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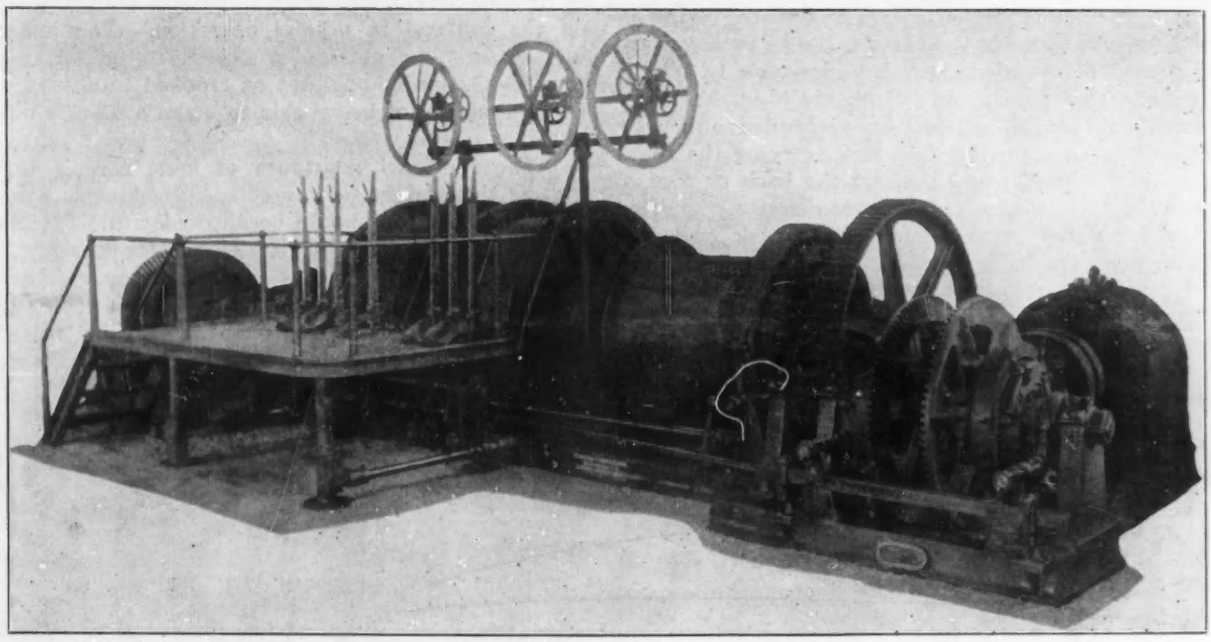
ELECTRICAL EQUIPMENT FOR METAL MINES[1]

R. W. SHOEMAKER.

Not the least important of the economies effected by consolidating a number of neighboring mines under one management are those resulting from a similar centralization of power supply, especially if this power be electric. In one district, where there were numerous shafts, each with its individual equipment of steam boilers, steam pumps, hoists and air compressors, there is now one central station of gas-driven alternators, supplying energy for each class of power at an actual saving of thousands of dollars a month in operating expenses. In one instance, a boiler plant was maintained at a shaft for operating a steam reciprocating pump handling 450 gallons per minute, against a 400-ft. head. This equipment was replaced by a six-stage centrifugal pump, operated by a 200-h.p. variable-speed induction motor, with a resulting saving of a little over $400 per month. Electric power was furnished from a steam turbine station, which was not operating under the best of conditions or the saving might have been greater.

Electric power, because of its convenience and economy, its flexibility and efficiency, its capability of transmission and its universality of application, is rapidly winning a place for itself in mining work.



Three-Phase Induction Electric Hoist at Mercur, Utah.

Mining men are interested not in the generation but in the utilization of electricity; whether it is generated by steam, gas or hydraulic power is of little concern to them. But in its application there are certain problems which seem peculiar to mining work. Some of these have been successfully solved, others have not.

Among the latter are electric drills, of which the least said the better, for there seems to be no way yet commercially developed for obtaining the pecu-

[1]Paper read before Los Angeles Section, A. I. E. E., Feb. 25, 1910.

liarly effective blow of the drill by electric means. It is true there is an electric drill, so called, on the market that has some good points, but it employs air as the transmission medium between the piston of the drill and the electric motor. This machine has the disadvantage of being in two parts, that is the motor and modified air compressor and the drill proper, which have to be connected by two lines of hose of limited length. These restrictions reduce the usefulness of this drill in many localities, though in others and for special conditions, the extra weight and extra apparatus form no objection.

Powder firing by electric caps is the only safe way of sinking a shaft, and no other method should ever be used. A battery should be used in this work, as current from a power circuit is unreliable, either discharging one or more holes when one side only of the firing line is connected to the mains or shunting part of the string of holes through grounds in the connections at the fuses. In the shaft, firing wires should hang clear of every obstruction as far as possible, to remove all possibility of leaks with resulting dangerous misfires.

Electric Haulage.

After the ore is broken and loaded in cars, electric haulage next requires attention. In this work, regulation street railway practice can be followed, with a few exceptions. In the first place, owing to the necessity of using the same drifts as passageways for men, mules, and motors, it is desirable to set the trolley wire outside of the rail instead of in the center between the rails. It can be suspended either by span wires crossing the drift and carrying the regulation hanger and ear, or, where the back or roof of the drift permits, placing a hanger directly connected to an expansion bolt. Fastenings to rock walls are easily made by drilling a 1-in. hole about 8 in. deep and driving in a ⅞-in. bar with an eye on the outer end and a split end with wedge on the inside. The act of driving swells the end inside the hole and firmly fastens the bolt.

Trolley frogs should be of 20 degrees, should be placed opposite the track frog, and pulled a little out of line on the straight-of-way, toward the curve. This is necessary on account of the swivel harp construction of mine locomotive trolleys. Track bonding should be under the fish plate, for mine cars frequently leave the track and play havoc with exposed bond wires. For temporary work channel pins and outside wires on one rail are sufficient, but should never be used on main haulage lines.

The usual mine locomotive is equipped with a plug connection from the cable leading down the wood trolley pole to the locomotive circuit. Where side trolley construction is employed the motorman is generally required to change trolley poles every round trip. Placing the socket with a live plug in the dark sometimes causes vigorous action on the part of the station circuit-breaker. A better method is to use two trolley poles, one on each side of the machine, with leads to a double-throw switch.

The trolley pole heads should not be fastened solidly on a wooden trolley pole with a pivoted harp carrying the trolley wheel, for when this pole leaves the wire the swivel head is likely to hook into the overhead wire, and if securely fastened to the pole and the pole is securely fastened to the motor, trouble results. By giving the head a "driving fit" nothing serious can happen, for in case the head hooks onto a wire when the locomotive is in motion it simply slips off with no resulting damage.

It is also desirable for locomotive motors to have split frames, for with this type new pinion or new bearing lining can be put in between shifts, or four hours, while with a solid frame the job takes about three times as long. Furthermore, the brushes should not be dependent upon the tension springs for current supply. Although this construction is obsolete on other classes of machinery, one manufacturer turns out locomotives with this construction, which may cause trouble if the machines have hard duty.

For operation on heavy grades with large loads and light rails or crooked track, tandem locomotives give excellent results. These consist of two-motor machines operating from one four-motor controller. They are slow and cumbersome on short hauls or in switching, but for long, heavy hauls they are much easier on the track than the equivalent machine on four wheels. The cable connecting the two machines should be arranged with plug ends fitting into sockets on the machines and care should be taken that no mechanical strain, due to a pull on the cable, can come on the contacts in normal operation. The maintenance and jumper cable is a difficult matter, especially if the motor operates on crooked track. Hence the desirability of being able to make a quick change of cables.

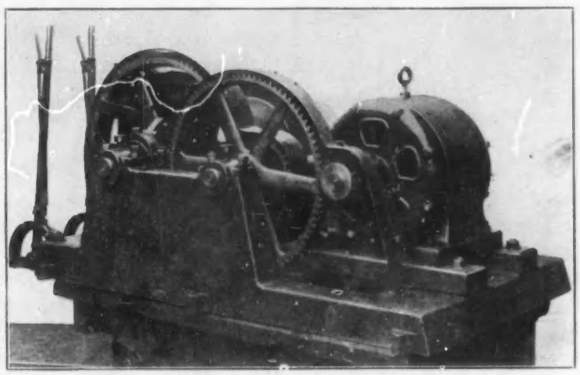
The frictional resistance of mine cars is much greater than might be suspected. Nothing less than 50 pounds per ton should be allowed, a 6½-ton locomotive should handle 69 tons on the level and 39, 26 and 19 tons on a 1, 2 and 3 per cent grade respectively. This would require an input of approximately 67 kw. These figures apply to cars on which divided axles or one loose wheel per axle are used. This construction allows a car to be easily handled on a curve but on reasonably straight track the continual oscillation causes high resistance.

The cost of laying underground track with 25-lb. rails, ties on 18-in. centers, bonds, etc., averages about $3000 per mile. The cost of the overhead in place, 000 grooved trolley wire, is $2400 per mile.

Electric Hoisting.

The substitution of electric for steam and air hoists is attended with great saving. In one instance the equipping of a steam hoist with a 50-h.p., 3-phase induction motor paid at the rate of 150 per cent a year on the investment, while for work at an underground winze or similar locations, the economy may be much more. In such places the average mining man places a small steam hoist and drives by compressed air. It may easily take, under these conditions, 100 i.h.p. at the air compressor to do the work of a 20-h.p. motor. If it is necessary to maintain air pressure outside of drilling hours for hoisting purposes, the efficiency may fall to about one per cent. In applying a motor to a hoist for given duty the minimum efficiency between the motor input and hoisting done may be taken at

46 per cent. This refers to a motor of continuous rating. The size of motor necessary for a steam hoist in operation is best obtained by taking indicator diagrams and expressing the torque in pound-feet. It should be noted that for a given size motor, load and depth of shaft, there is a certain fixed hoisting velocity



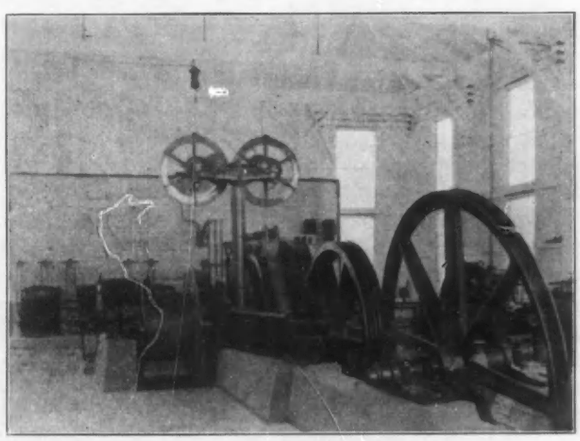
Cripple Creek Type of Electric Hoist.

that will give a minimum hoisting period. A greater velocity loses time in acceleration, and a loss in running time after full speed is reached.

Referring again to the inefficiency of compressed air, I have seen a 350-h.p. air compressor working at top speed to maintain pressure enough on the pipe lines to operate two Cameron pumps, which were subsequently easily driven by one 3-h.p. motor. The efficiency in this case between the steam cylinders of the air compressor and the weight of water lifted was 0.21 per cent. This is an actual case from practice and at a plant that was supposed to be up to date.

Electric Pumping.

The steam pump at its best is an inefficient piece of apparatus. Tests show a compound condensing pump, 20 and 38 x 13 x 36 in., to require about 10 lb.



Balanced Hoist at Union Shaft, Virginia City, Nevada.

of coal per i.h.p., including boiler losses, condensation, etc., while a centrifugal pump, direct connected, has an efficiency of about 61 per cent, or say 5.6 lb. coal per i.h.p. With a plunger pump a better figure than this can be obtained, but the centrifugal is cheaper to install.

The motor for pumping duty should not be wound for over 440 volts. Form wound coils, heavily treated with water-proofing compounds, should be used. The rotor should be of the constant speed type, variation in water flow being taken care of in the centrifugal by throttling the suction, and in the plunger pump by by-passing one or more cylinders.

The pump should be placed as high as possible above the sump to allow ample time for the water to rise in case of accident. With a centrifugal pump no trouble will be experienced with a suction head of 25 ft., barometer averaging 29 in. For heading pumps handling over low lifts a plunger type should be employed, as the pumps must operate without attention and must be self-priming.

Underground Lighting.

Wiring for underground lights should be done very carefully. Ordinary insulation is useless after a few months underground, and reliance has to be placed on porcelain or glass. Weatherproof sockets only should be used and these, preferably, of hard rubber, or composition. Moulded mica disintegrates and porcelain breaks too easily. The number of switches underground should be kept at a minimum and only knife blade types of not less than 50 amp. capacity. Miners always operate switches with a club where possible.

Leads down the shaft should be in iron pipe unless acid water is present. Triple braid, rubber-insulated wires fastened to an iron messenger wire to carry the weight and protected by iron pipe is much more satisfactory than lead-covered cables for this work. A lead-covered cable for vertical work such as in a shaft is a delusion and a snare and is almost sure to give trouble. In one case satisfactory operation was obtained from a lead cable which was installed in the following manner: A 000 stranded, 3-conductor, rubber-insulated and lead-covered cable was fastened to a 5/16-in. galvanized strand wire by tape every 2 ft., and lowered down a 3½-in. pipe, the strand wire taking all the weight. After the full length was in place, about 500 ft., the lower end of the pipe was closed around the cable with cement, the pipe filled with hot sand and the top sealed. The cable was thus supported throughout its length and failure could not take place. The lead covering was practically useless as a protection in this case.

Mill Equipment.

In mill work, when dirty water and a multitude of belts are found, conduit work is the only satisfactory method. Long drops should be avoided, and, as in underground work, the number of switches should be limited. Usually a point can be selected that is central and exposed to a minimum of water and dirt to which all lighting circuits should be run.

Incandescent lamps should be low priced, the efficiency being sacrificed for this point. Where power is generated by the owner at low cost there is no economy in buying high efficiency lamps that soon become covered with a more or less opaque coating of mud and dirt, or else broken. In such cases, where the cost of the power required to operate a lamp is a fraction of its initial cost, it is advisable to keep the

initial cost low, at the expense, perhaps, of a slight increase in the operating power cost.

The use of electric motors in driving concentrating mill machinery is quite common. The delays in a mill driven by a line shaft running the full length of the mill and driven by a steam engine at one end are many times the delays in a properly subdivided and electrically driven concentrator. For example, in the same field a mill of the first class is operating with delays averaging 9.6 seconds per ton milled per day, while nearby another of the second class has delays of 27 seconds per ton milled per day.

The induction motor is the only one that should be considered for this class of work, and for this duty high-efficiency, high-power factor machines should be overlooked for motors with a rather large air gap, form wound coils and a generous rating. The use of partially closed slots with coils formed in place is sure to bring trouble in work of this character where dirt, water, and usually more or less indifferent attention and care are given the machines.

After a motor of the partially closed slot type has had good steady use and it becomes necessary to replace a few coils it is usually found that the insulation on the other coils is so brittle that they cannot be taken out of the slots without damaging the insulation beyond repair. It then becomes necessary to rewind the entire machine, when with wide-open slots a few new coils would have been sufficient.

The rotor for mill work can generally be of the squirrel-cage type, but should have a rather high resistance so a good torque can be had on starting. The connections between the rotor bars and end rings should have ample area and depend for mechanical strength on rivets or screws.

For operating the crushers, a motor with slip rings and external resistances of suitable capacity for continuous operation should be used, as crushing machinery is liable to have large inertia. In one case a section comprising a 24 x 42-in. Blake type crusher and three 24 x 48-in. rolls required full load torque from a 250-h.p. motor for 7 to 15 minutes to get up to speed. After reaching speed the power required was 114 h.p., unloaded. On crushers and rolls the motors should be protected by circuit-breakers with an inverse time limit attachment, so that momentary peaks do not throw the load off and leave the crusher choked. For other classes of work the plain fuse is all that is required.

On large centrifugal pumps for mill work there is an excellent opportunity to use synchronous motors and furnish some of the magnetizing current required by the induction motors. No trouble will be experienced with the synchronous motor starting as an induction motor on reduced voltage, when directly connected to a pump, if a short-circuited winding is applied to the field poles.

The motor circuits should be in conduit, differing from the lighting circuits in that there should be plenty of switches to subdivide for the purpose of repairing or attaching new branches. Milling is a continual change and usually the plant is no sooner running than there will be changes or additions to be made. At each motor there should always be placed a switch disconnecting everything from the line, so fuse blocks, circuit-breakers or compensators may be repaired without danger. It should be remembered in this connection that in milling work 24 hours a day and six days per week is the minimum working time allowed and often the plant will run continuously, hence suitable provision must be made for repair work.

Motors should never be on the same floor with jigs or tables, but should be placed on piers at least 40 in. high or in the roof trusses, the latter being better. The writer has noticed careless jig men play a hose directly in a motor, not so placed, for several seconds at a time, which is hardly beneficial.

Telephones.

The telephone system for any but a small proposition should be the manual in preference to the automatic, as the telephone operator is a handy person to do small chores, which in the automatic the calling party would have to do himself or leave to his assistant at a greater expense in salary perhaps than an operator would cost. A generous use of telephones always pays. They should be underground at the principal points as well as on the surface. The lines in the shaft should be of No. 14 double-braided, rubber-covered wire fastened to a galvanized iron wire as a messenger and lowered in ¾-in. pipe with the ends sealed with compound. Any other type of construction will give trouble. In the workings the wire should be carried clear of everything on large insulators or else in pipe and the point of changing from conduit to open work should be in a dry place. The telephone instrument itself, for underground work should be mounted in an iron box with a tight-fitting door. By mounting a 16-c.p. lamp inside the box to keep it warm as satisfactory service can be had underground as on top. If the warming lamp is left out moisture will make short contacts in a few weeks, so that on a common battery system, which is preferable to a magneto, the line will show busy.

Usually when a telephone is mounted in a mill the vibration makes conversation almost impossible. Sound-proof booths, so called, are of no avail, but if the transmitter is suspended from a coil spring about 4 in. long the vibration disturbances will be eliminated. The same construction can be supplied to advantage in the engine rooms or any place subject to powerful vibrations.

If power circuits are adjacent to telephone lines, plenty of protection in the way of fuses should be provided. Where the wires enter the cable, fuses and arrester equipment should be used and again at a distributing rack before entering the switchboard. Each instrument should be protected by arrester and fuse. By using ½ amp. fuses at instruments and cable box, and ¼ amp. in the distributing rack, and also by having two spark gaps in series to ground at the cable box, light disturbances will blow out only the ¼ amp. fuses; these are accessible and easily replaced. A heavy discharge or cross with a power line will open all fuses. On a telephone system constructed as above an accidental cross with a 10,000-volt power circuit did not reach the switchboard or instruments, the fuses and lighting arresters completely protecting the equipment.

THE WATTHOUR METER.

BY WM. M. SHEPARD AND ALLEN G. JONES.

CHAPTER V.

THE MERCURY FLOTATION WATTHOUR METER.

(Continued.)

The Mercury Flotation Watthour Meter.

The Sangamo Electric Company of Springfield, Ill., manufactures a type of watthour meter which is

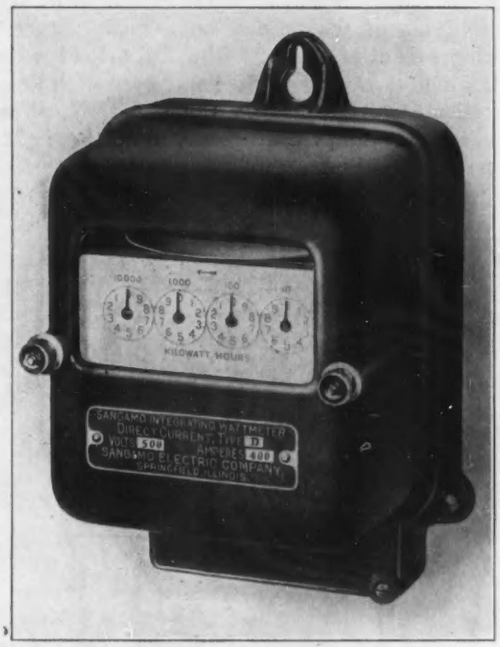


Fig. 61a. Sangamo Meter.

radically different in operation from the induction and commutating types of meters previously explained. The Sangamo meter is of the mercury flotation type

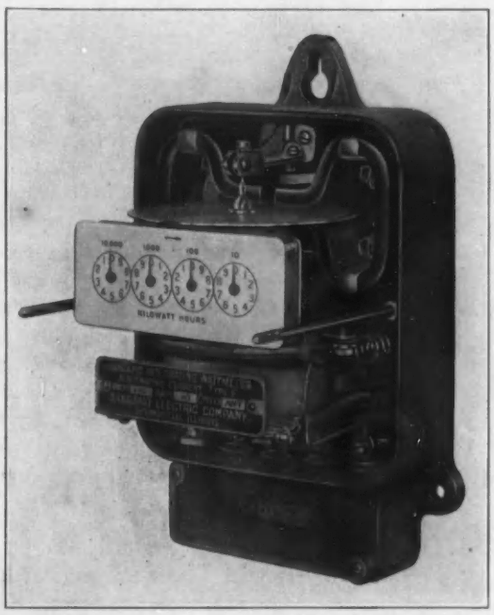


Fig. 61b. Sangamo Meter, Cover Removed.

and its principle of operation is based on an old discovery made by the scientist, Faraday, when he found that a pivoted metallic disc carrying electric current would tend to rotate when under the influence of a magnetic field.

The fundamental discovery of Faraday is very ingeniously utilized in the Sangamo meter. A copper disc is enclosed in a suitable chamber made of moulded insulating material which is divided horizontally into two sections, the chamber being partially filled with mercury. In the lower part of the mercury chamber there are imbedded two copper terminals which serve to conduct the current to the copper disc through the intervening mercury. The mercury serves the double purpose of conducting the current to the disc and of buoying up the disc so as to make the weight on the

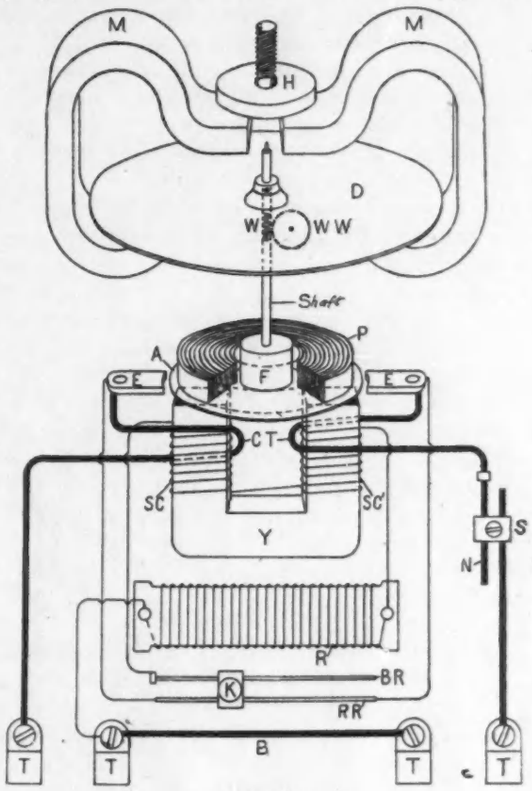


Fig. 62.

lower bearing very slight. The copper terminals are arranged diametrically opposite as will be seen from Fig. 62. The exciting magnet which produces the flux which acts upon the disc is imbedded in one section of the moulded "mercury chamber."

In the case of the direct current Sangamo meter the main line current, or a proportional part thereof, passes through the copper disc, the magnet being excited from the potential of the circuit upon which the meter is being used. In the case of the alternating current meter, the method of excitation is opposite from the direct current meter, that is, the magnet is excited by the line current, and the disc carries a current which is proportional to the potential of the circuit.

The reaction of the current in the disc with the magnetic lines of force from the magnet will cause the disc to rotate at a speed which will be proportional to the product of the current and the impressed e.m.f., in other words, it will rotate at a speed which will be proportional to the power being expended in the circuit

to which it is connected. In alternating current meters operating on a circuit whose power factor is other than unity, the speed of rotation will then be proportional to the current, the e.m.f., and the power factor.

Under ordinary conditions a variation in temperature between 10° F., below zero, and 110° F., will not materially affect the operation of the mercury meter, but temperatures above or below these maximum and minimum values are liable to affect the accuracy. There is sufficient space in the mercury chamber and such a (comparatively) small percentage variation in the volume of the mercury with changes in temperature that the expansion of the mercury will not cause it to leak out, as is sometimes supposed.

The direct current Sangamo meter cannot be used on alternating current circuits because of the high self-inductance of the potential winding. Therefore, if alternating current be applied to a direct current meter very little current would pass through the potential coil, and even that would lag by so many degrees that it would produce a very small torque.

Fig. 62 shows diagramatically the Sangamo direct current meter. The damping system in this type of meter is essentially the same as previously explained in connection with induction and commutating types of meters. In the above figure the damping magnets are shown at M, and the damping disc at D. The copper terminals which lead the current into the mercury and thence to the disc, A, are shown at EE. The external resistance, R, is in series with the potential winding, SC. The light load adjustment is made by moving the slider, K, to the right or left, thereby causing part of the shunt current passing through the potential winding to flow through the armature. This current reacting with the magnetic field from the potential winding produces a no-load torque which is sufficient to compensate for friction.

The torque of the Sangamo meter is very low, the torque of a 5 ampere direct current meter being only about 20 gram-millimeters. It may be said, however, that in the case of the mercury flotation meter the pressure on the jewel bearing is relatively small, and it is therefore not necessary to have as high a torque as in other types. The reason for this low torque in the Sangamo meter is due to the fact that the armature is equivalent to only one turn, and as it is not practicable to carry more than 8 or 10 amperes through the armature, the effective armature turns will necessarily be low. Current shunts are used in all direct current Sangamo meters having a capacity of more than 10 amperes, the shunt being external in large capacity meters and internal in the smaller sizes. The sliding connector, S, shown in Fig. 62 is used for adjusting the armature current with respect to the shunts.

It is not feasible to build the mercury meter for three-wire direct current service, since it would necessitate the construction of two separately insulated mercury chambers and armatures, which would of course be too bulky, complicated and expensive to be warrantable. Two mercury meters have to be used where it is desired to measure the power in a three-wire direct current circuit, with this type of instrument.

The alternating current meter of this type is shown diagramatically in Fig. 63. As will be noted, the armature circuit is in shunt with the source of supply in this case, as was above mentioned, rather than in series as is the case with the direct current type. The small potential transformer, N, has its primary, PT, connected across the line and induces through its secondary, MS, a current of high amperage and very low e.m.f. This current flows directly through the armature as is shown. The actual value of this secondary current is between 12 and 20 amperes at an e.m.f. of approximately 0.05 volt. The transformer also has an auxiliary secondary winding, AS, the terminals of which are connected through the variable resistance, RR, to the light load adjusting coil, J, which is wound on the same core with the series field coils, FC. By moving the slider, K, along the resistance the compensating effect of the light load

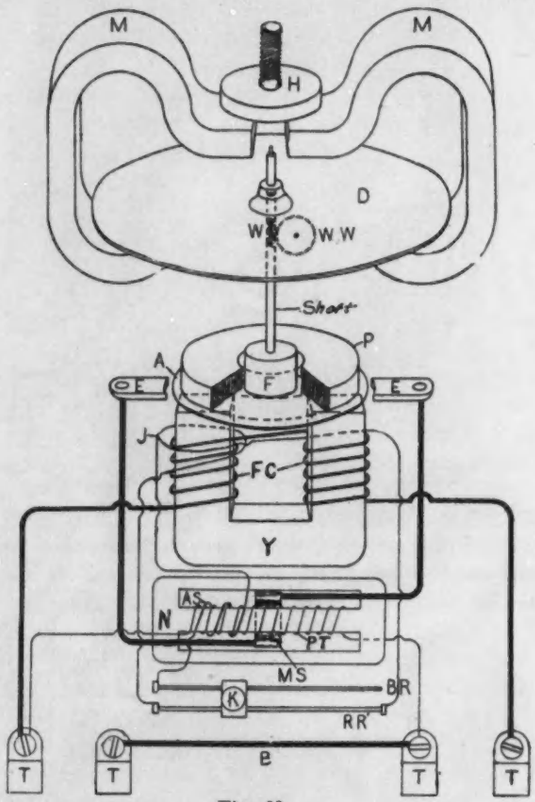


Fig. 63.

The full load adjustment in the Sangamo meter is quite different from the usual practice, in that the damping effect of the retarding magnets is varied by "shunting" more or less of the magnetic lines through a soft iron disc, H (Figs. 62 and 63), which is placed directly above the magnet system, rather than by moving the magnets themselves. This soft iron disc is movable in a vertical direction as shown; by bringing it in close proximity of the magnets, it weakens their effect, thereby causing the meter to run faster.

The Ampere-Hour Meter.

The Sangamo ampere-hour meter, is now being used quite frequently in connection with the charging and discharging of storage batteries. Storage batteries are rated on their ampere-hour capacity, and it will therefore be seen that an instrument which will indicate the amount of current that has been stored in, or the amount of current remaining in a battery is a

valuable accessory to the electric automobile garage, or in fact to any one having the care of a storage battery.

The construction of the Sangamo ampere-hour meter is essentially the same as that of the watthour meter, except that the exciting electro-magnet is replaced with a powerful permanent magnet. The turning effort of the armature will therefore be independent of the potential of the circuit on which the meter is used, being directly proportional to the current passing through it. This type of meter is usually furnished with a single pointer, which will show at a glance the condition of the battery with respect to the charge or discharge. The dial may be furnished with a movable contact, which by means of a relay can be made to open the main circuit through a "shunt-trip" type of circuit-breaker; this movable contact can be set so as to open the circuit at any predetermined value.

Connections.

A few representative connections of the Sangamo meter are shown in the following figures:

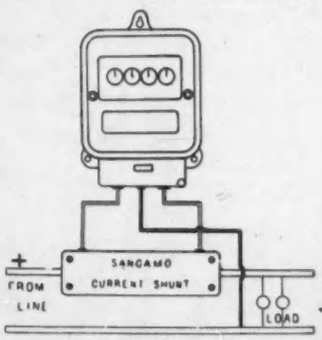


Fig. 64.

Two-Wire D. C. Meters—110 to 250 volts; 100 to 400 amperes, inclusive, box type "Current Shunt." New "Pocket Type" Shunt used in capacities 100 to 200 amperes, inclusive, except for street railway service.

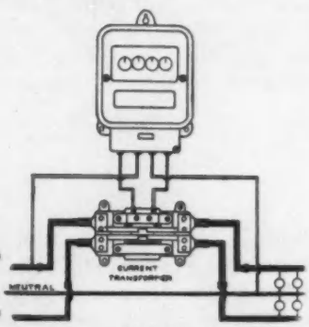


Fig. 67.

Three-Wire Alternating Meters—110-220 volts single-phase; capacities 200 amperes per side and over. With Current Transformer having two primary windings.

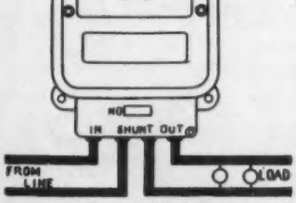


Fig. 65.

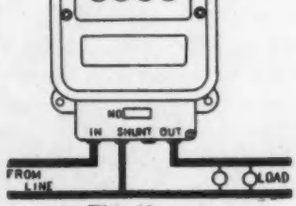


Fig. 66.

Two-Wire Meters—110 and 220 volts, for A. C. Meters 5 to 100 amperes; D. C. meters 5 to 80 amperes, inclusive. Meters may be connected according to Fig. 65 or Fig. 66, but the former is preferable, as this method prevents tampering with the meter connections.

Fig. 68.

Service type, ampere-hour meter, 10 to 100 amperes internally shunted.

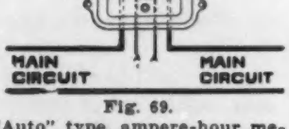


Fig. 69.

"Auto" type, ampere-hour meter, with contact device and auxiliary circuit for tripping a circuit-breaker. Capacity 10 to 100 amperes.

(To be continued.)

ELECTRIC MINE HOISTS.

The March meeting of the American Institute of Electrical Engineers in New York City was devoted to a discussion of electric hoisting in mines. Two papers were presented, one by D. B. Rushmore and K. A. Pauly was mainly devoted to a comparison of different systems, and the other by Wilfred Sykes detailed the mathematical calculation of load diagrams and a descriptive account of the various balancing systems. Following is an abstract of the descriptive and comparative portions developed in the first paper.

Mine hoists are usually driven by either shunt-wound direct current motors or by polyphase alternating current induction motors. Speed variation with the shunt motor is best obtained by changing the supply voltage. Speed control of an induction motor is obtained by changing the amount of resistance connected in its armature circuit. In lowering unbalanced loads the shunt motor may be driven as a generator, acting as a brake at all speeds and returning power to the system. The induction motor also generates but only when driven above synchronous speed.

For a given torque the input to the shunt motor is approximately proportional to the speed, while that of the induction motor is constant and independent of the speed. At low speeds the shunt motor is consequently the more efficient. The free-running speed of each motor is limited and change in load has little effect upon speed variation.

As pointed out, the efficient speed control of the shunt motor is only obtained by varying the voltage of the supply system, the usual method being to provide a generator for each motor and varying the generated potential. As mine shafts are usually scattered over a considerable area, and the conditions in close proximity to the shafts are not such as to permit of the economical generation of electric power, the central electric station is usually placed at a considerable distance from the hoists, the power is generated and transmitted to the mines as alternating current and is then transformed at each shaft into direct current by motor-generator sets. The losses caused therein must be charged against the shunt motor when comparing its efficiency with that of the induction motor, which may be connected either directly or through highly efficient static transformers with the alternating current distributing system. The torque and current for the two types of motor are approximately proportional within their operating limits.

Mine hoists may be divided into six types, depending upon whether the rope is wound on a reel, a cylindrical drum, conical drum, cylindro-conical drum, Whiting drums, or carried over a Koepe disk, the choice of any particular type depending largely upon the depth of shaft, the maximum permissible hoisting speed, the location of the hoist with respect to the shaft, the number of levels which are being worked simultaneously, and whether or not the shaft conditions permit the use of a tail rope.

The hoists are generally operated in balance, that is, the weight of the skip (or cage and car as the case may be) carrying the ore, is balanced by a similar empty skip which is lowered in a second compartment simultaneously with the hoisting of the loaded skip in the first, the loaded skip being dumped at the top and

the empty one loaded at the bottom, and the cycle then repeated. To permit of adjustment of the length of the ropes for hoisting from different levels, it is customary to use two reels or drums mounted on the same shaft, one being keyed to the shaft and the other being driven by it through some form of clutch. The length of rope on the Koepe disk hoist or the Whiting hoist cannot conveniently be adjusted for different levels except within very small limits.

Many systems of electric hoisting have been proposed, each with the view of meeting some peculiar condition, or eliminating some real or apparent objection in the others, but virtually all the installations are confined to four systems shown in Figs. 1, 2, 3 and 4.

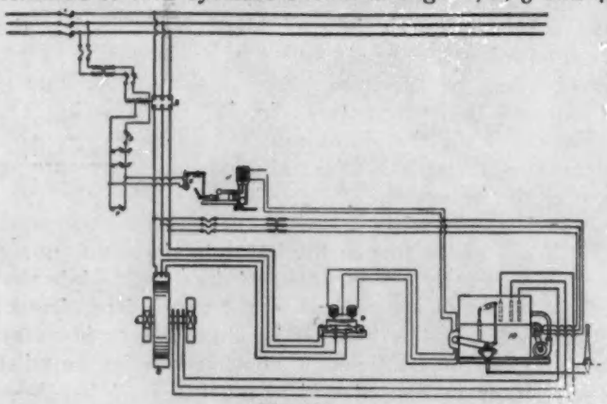


Fig. 1

The first and simplest system is shown in Fig. 1, and consists of a polyphase induction motor, direct connected or geared to the hoist drum. The speed of the motor is controlled by a variable resistance in its rotor circuit, which, because of the magnitude of the currents involved, is usually some form of water rheostat. A common type of water rheostat consists of a tank, usually of boiler plate riveted together, and divided into two compartments; one the rheostat proper, and the other a cooling tank. The electrolyte is pumped from the cooling tank into the rheostat proper, entering at the bottom of the rheostat and flowing out over the top of an adjustable weir, back into the cooling tank. The resistance in the rotor circuit is varied by changing the height of the electrolyte in the rheostat proper by means of the adjustable weir. The electrodes are usually thin iron plates hung on insulators, all phases being in the same compartment. At least one electrode per phase is of extra length, extending below the lowest level of the liquid, in order to prevent the rotor circuit from being opened. The most common form of electrolyte is a simple salt solution. The control of the rheostat is by means of a lever located on the operating stand.

The horsepower and current taken by the motor are constant during the period of acceleration; the efficiency for this period is very low, approximately 45 per cent. No power is returned to the supply system during the period of retardation, and the power consumption for small movements of the cage or skip is very large. On the other hand, the efficiency when the hoist is running at full speed is high, approximately 90 per cent, and no power is consumed while the hoist is at rest. About 20 per cent of the power taken for hoisting is returned in lowering.

The second system is that shown in Fig. 2. In this system the hoist is driven by a direct-current shunt-wound motor receiving power from the alternating-current supply system through a synchronous or induction-motor-generator set. The hoist motor is controlled by varying the voltage of the generator, which is separately excited, one generator being used for each motor.

The power consumed during acceleration is much smaller than for the induction hoist motor, the efficiency then being approximately 80 per cent, and a considerable part of the energy stored in the revolving parts of the hoist is returned to the supply system as the hoist is brought to rest. On the other hand, the

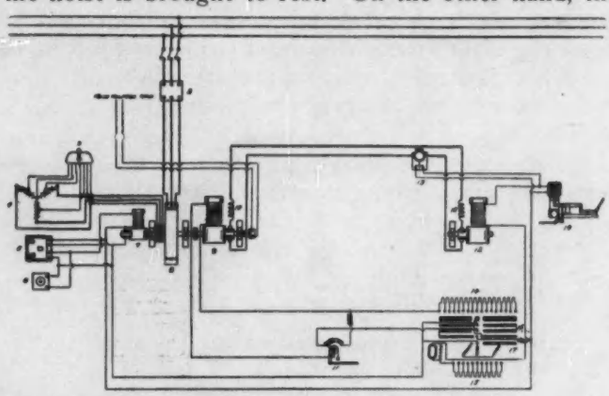


Fig. 2

efficiency when the hoist motor is running at full speed, is lower than that for the induction hoist motor, being approximately 82 per cent, and the losses of the motor-generator set when running light, must be supplied during the time when the hoist is at rest. In view of the fact that a mine hoist is idle 50 per cent or more of the time under ordinary conditions, this is an item in the total power consumption which cannot be neglected. It follows from what has been stated, that the advantage of the direct-current hoist motor over the induction hoist motor in the efficiency through the complete cycle is greatest for short lifts, in which case the period of acceleration is a large percentage of the total cycle and the time during which the hoist is idle is a minimum. Approximately 30 per cent of the power consumed in hoisting the ore unbalanced is returned to the system when the skip is lowered.

No definite rule can be laid down by which a choice can be made between the two systems, each having advantages and disadvantages peculiar to itself which have a more or less important bearing on the choice, depending upon the special conditions of the individual problem. The first system has the advantages of low first cost and simplicity, but is often at a disadvantage in respect to efficiency. On the other hand, the higher efficiency of the second is frequently more than offset by its increased first cost and its greater cost of maintenance.

Both systems are open to objection that the power drawn from the supply system fluctuates between very wide limits during each cycle, generally reaching a maximum during acceleration, becoming negative during retardation for the second system, zero, or practically so, at the end of the cycle, and negative when lowering unbalanced for both systems. The effect of

this wide fluctuation in the load during each cycle, is to seriously impair the voltage regulation of the supply system unless its capacity is large as compared with the fluctuations, or unless the number of hoists driven from the same system is sufficient to produce a fairly uniform load, which is seldom the case for a mine power system. Also, if power is purchased, the price is usually made up of two components; one based on the total kilowatt hours consumed, and the other on the maximum demand.

It therefore becomes necessary in most cases to provide some means whereby power may be taken from the supply system and stored during the portion of the cycle when the demand for power is less than the average, and returned when the demand exceeds the average.

Fig. 3 shows such a system, the third, in which advantage is taken of the low first cost and efficiency of the fly-wheel as a means for storing and returning large quantities of power for short intervals. This system is similar to the second, except for the addition of a fly-wheel to the induction motor-generator set, and an automatic regulator for varying its speed. In its most common form, this regulator consists of a water rheostat connected in series with the induction

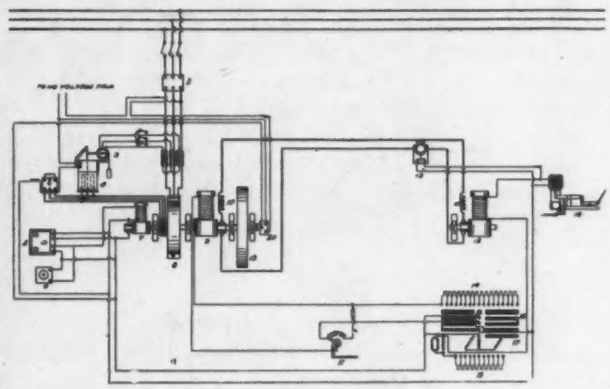


Fig. 3

motor armature. The resistance is varied by means of movable electrodes suspended from an arm mounted on the shaft of an induction motor, which is connected in series, either directly or through series transformers, with the induction motor of the fly-wheel set. The regulator motor is so connected that its torque opposes the weight of the electrodes, which are partially counterbalanced to reduce the size of the regulator motor to a minimum, and permit of an adjustment of the regulator for different values of line current. When the line current exceeds the value for which the regulator is adjusted, the torque of the motor overbalances the weight of the electrodes, lifting them and inserting resistance in the armature circuit of the induction motor. This causes it to slow down, and allows the fly-wheel to assist in driving the generator during the peak loads.

The fourth system is used when, for the purpose of meeting some peculiar condition, it is advisable to drive the hoist by an induction motor and at the same time eliminate the peaks from the station load. The adoption of this system is warranted when the hoist is located underground at such a distance from the surface that it becomes necessary to transmit power to it by alternating current, and when the shaft is not large enough to allow the fly-wheel of the motor-generator set to be taken underground.

Fig. 4 shows this system, which it will be noted is the first system, to which has been added a converter equalizer, consisting of a rotary converter

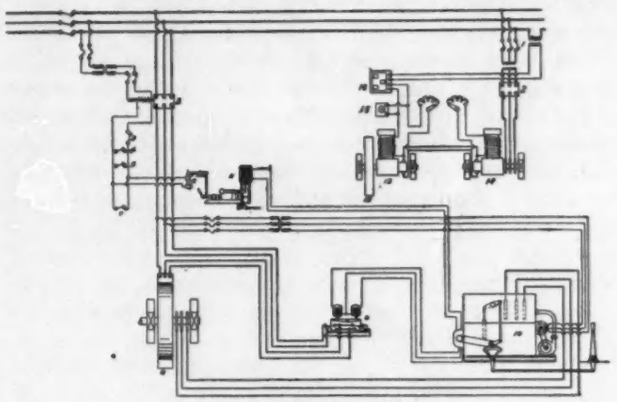


Fig. 4

connected on the alternating-current side to the supply system, and on the direct-current side to a motor driving a large fly-wheel. The field of the direct-current motor is controlled by a regulator actuated by the line current. When the power taken by the hoist

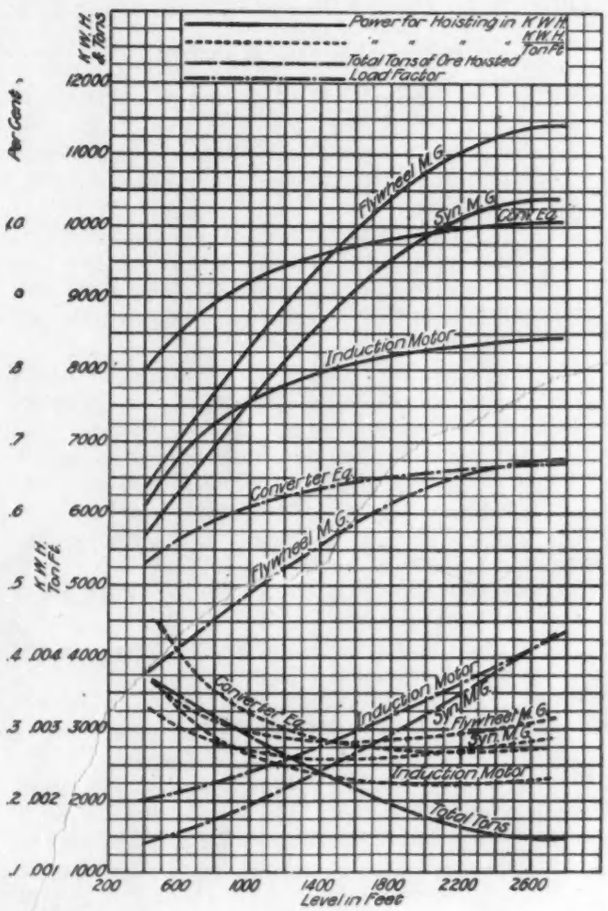


Fig. 5.

motor drops below the average, the field of the motor is automatically reduced, and the fly-wheel is speeded up, the power being taken from the supply system.

When the hoist-motor load exceeds the average, the operation is reversed, the fly-wheel slowing down and returning power to the system.

The efficiency of this system is generally slightly lower, and the weight of the fly-wheel is slightly greater than for the direct-current motor and the fly-wheel motor-generator set. It has the advantage, however, over the third system, in that the operation of the hoist motor is not dependent on the operation of a converter equalizer. Consequently, in the event of the failure of the latter, hoisting may be continued, providing, of course, that the capacity of the power system is sufficient to take the load, which would be the case if the equalizer were used simply to reduce the power bill.

Either the third or the fourth system may be used where the supply system is direct current, by substituting a direct-current motor for the induction motor of the fly-wheel motor-generator set in the third system, and omitting the synchronous converter of the fly-wheel converter system in the fourth.

The curves in Fig. 5 give the total tons hoisted, and the total kilowatt-hours consumed (per day of 24 hours), the kilowatt-hours consumed per ton (2000 lb.) foot, and the load factor for each of the four systems when hoisting 10,000 lb. per trip in balance from vertical depths varying from 400 ft. to 2600 ft. by a reel hoist.

PRACTICAL MECHANICS.

Paper 12.

TOOTHED GEARING.

In the present paper we shall take up the case of transmission of pure rotation by means of toothed gearing.

Toothed gearing is a special form of friction gearing and is included in the second of the five divisions of mechanical transmission which were outlined in the first of this series of papers. (See Journal of Electricity for Jan. 1st, 1910.)

Toothed gearing possesses certain advantages over friction gearing, which advantages are the entire elimination of pressure normal to the disc surfaces and the consequent absence of bearing adjustments necessary to maintain this pressure. As a result of this, toothed gearing has come into general use except in cases where it is sometimes necessary that slipping be permitted. Further, it is possible to transmit enormously greater amounts of power than could be done through friction gearing.

As in the previous cases, we shall investigate our subject under the three conditions:

First. Axes of rotation parallel; spur gears.

Second. Axes of rotation intersecting; bevel wheels.

Third. Axes of rotation crossing; skew wheels.

We shall consider at some length the design of spur gear teeth and touch, more briefly the other two forms, since the same principles of design are involved in all three cases.

Toothed gearing is a special form of friction gearing in which certain projections upon and depressions within the rotating bodies are made to mesh, so that they are driven by direct contact.

In the case of friction gearing the velocity ratio was found to be constant for circular bodies, and inversely equal to the ratio of their respective radii. In the case of toothed gearing the same relations exist. If we were to consider two circular discs, one driving the other through frictional contact, the circumferences of these discs would be known as the pitch circles. In friction gearing these pitch circles are imaginary, but serve to determine the velocity ratio and distance between axes just as the actual discs do.

Any sort of projections and depressions would serve to effect transmission of motion from the one body to the other, but to insure a constant velocity ratio it is necessary that the imaginary pitch circles be considered.

In all cases, then, of toothed gearing the teeth are considered as fixed upon these imaginary pitch surfaces. The diameter of the surface is known as the pitch diameter, and the distance from the face of one tooth to the corresponding face of the next tooth on the same wheel measured on an arc of the pitch circle is called the pitch of the tooth, or the circular pitch.

The design of the tooth surfaces so that the angular velocity ratio may be constant, the driving positive, and the velocity of sliding as small as possible, is the chief problem.

There are three forms of teeth which have been found to accomplish the above requirements with the best results. These are known as the epicycloidal, the involute and the conjugate teeth.

We shall study the epicycloidal tooth first. A cycloid is the curved path traced out by a point on the circumference of a circle when this circle is rolled along a plane surface. Figure 10 shows such a cycloid of revolution. If the same circle were rolled around the circumference of another circle, the point of the first circle would describe an epicycloid, and if it were rolled on the inner circumference the path generated would be termed a hypocycloid. Figure 11 shows an epicycloid and a hypocycloid generated by such a circle rolling on the exterior and the interior of an arc of a larger circle.

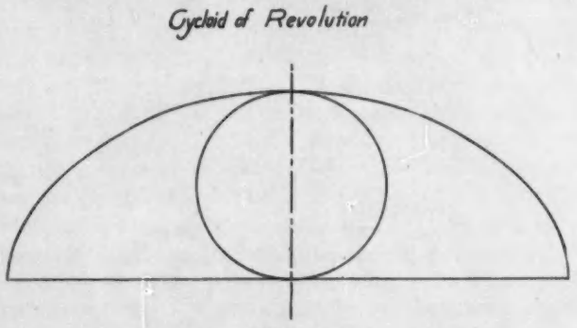


Fig. 24.

Figure 12 shows the application of this cycloidal curve to gear teeth. The two circles with centers at A and B are pitch circles in rolling contact at I. The generating circle with center at S is in contact with both circle A and circle B at I. A point on circle S therefore generates an epicycloidal curve $e_o e$ with reference to circle B and a hypocycloidal curve $h_o h$ with reference to circle A. The point P is, at the instant, under consideration, generating these two cycloids, and is therefore their point of contact.

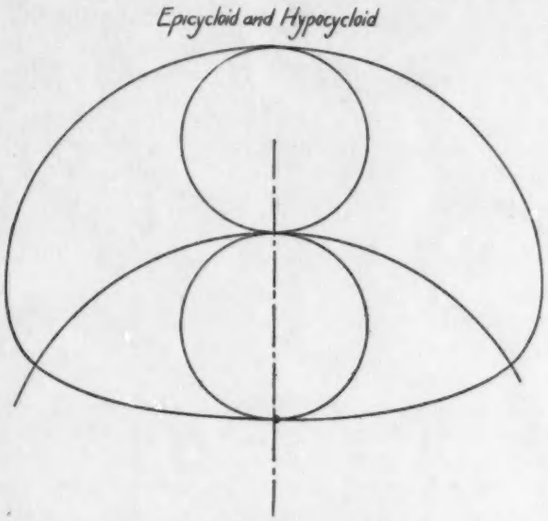


Fig. 11.

In the completed gear this point of contact P is the point where the actual driving is done. It will be remembered that the first requirement for successful gearing is a constant angular velocity. Since the

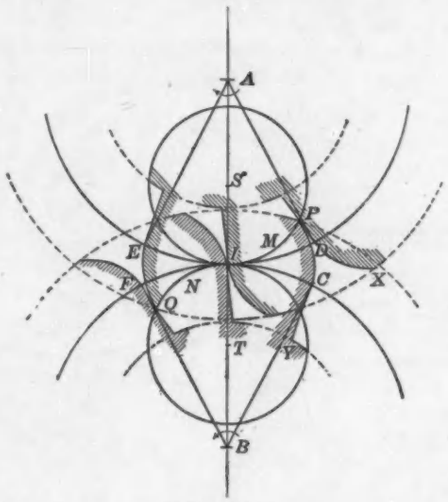


Fig. 12.

velocity ratio is inversely proportional to the respective radii of the circles A and B, their point of contact I must be fixed in position—i. e., must remain in such a position that the ratio $\frac{AI}{BI}$ is constant.

Now, I is the center of relative motion between A and B. It will be remembered from an earlier paper that the three centrodes of motion must lie on the same straight line.

It may seem, at first thought, that the cycloidal development of Figure 12 does not fulfill the above necessary condition for constant velocity ratio, but a little further study will show that it does so.

The only possible motion of the two cycloids e•e and h•h is a sliding motion at the point of contact P. This sliding must be in the direction of the common tangent to the surfaces or perpendicular to the common normal PI. (It can be shown that this common normal will always pass through the imaginary point of contact I.) Hence the relative motion due to the sliding at P is the same as though the pitch circles were actually in rolling contact at I.

Therefore it may be said that for a constant angular velocity ratio the tooth outlines must be such that their normal at the point of contact shall always pass through the centrode corresponding to the required velocity ratio.

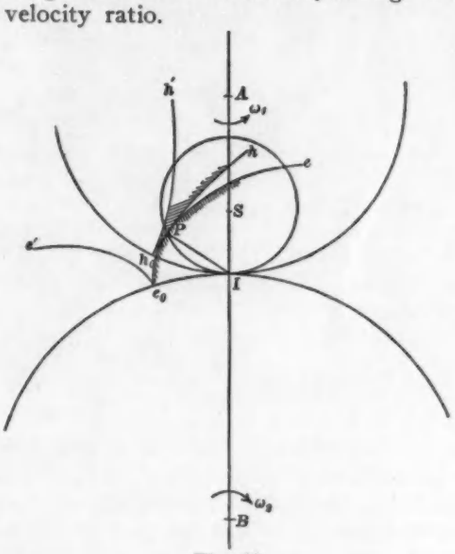


Fig. 13.

In the figure (13) driving will take place on the left side of the line of centers AIB, and the curve ($h_o h$) will push the curve ($e_o e$) along, A being the driving and B the driven circle. As P approaches I, however, h_o approaches e_o until they eventually coincide at I. Beyond I to the right the curves $e_o e$ and $h_o h$ are no longer in contact, but another pair of cycloids, $e_o e^1$ and $h_o h^1$ are traced out. Obviously now the driving could not be from A to B since the tendency would be for $h_o h^1$ to separate from $e_o e^1$ instead of to drive it forward by pushing as on the left side of the line of centers.

This may be overcome by using a describing circle similar to circle S within each of the pitch circles.

Figure 13 shows the complete tooth development in this manner. In addition to describing circle S there will be noted describing circle T. The action of these two circles in describing the teeth tips and flanks is as follows: Point P of describing circle S traces the face PC of the tooth of B, and the flank PD of the tooth of A; while the point Q of the circle T traces the face QE=face DX of the tooth of A, and the flank QF=flank CY of the tooth of B.

We see that in this case the locus of contact of two teeth will be PMINQ, and hence the driving is continuous from the first instant of contact to the point of separation on the opposite side.

Any two gears having the same pitch of teeth will mesh together and work correctly, provided that the same describing circle has been used in laying out the tooth surfaces. The reader who desires to fix the principles of cycloidal teeth development well in mind should lay out the tooth surfaces on paper, drawing in the various curves for himself.

In laying out the teeth of a complete gear it would be necessary to carefully develop the surface of one tooth and from this surface make a template. By

swinging this template along the pitch circle the successive tooth surfaces may be quickly and accurately drawn in, the circulan pitch having been previously determined and indicated on the pitch circle.

The determination of the circular pitch is made with consideration of the size of the gear and the amount of power to be transmitted.

If the speed of the driving shaft, say, is known, and the amount of power to be transmitted then the torque, or turning effort at the pitch circumference of the gear may be calculated. Thus, if F = the force to be transmitted at the pitch circumference of radius r, N = the number of revolutions; then the work $W = 2 \pi r F N$ from which

$$F = \frac{W}{2 \pi r N}.$$ Or since horsepower = work per unit time this may read $$F = \frac{HP.\ 33{,}000.}{2 \pi r N.}$$

When this maximum force is known the teeth may be given proper proportions. The dimensions upon which the tooth depends for strength are the thickness, the length (width of gear face) and the depth of space between teeth. As soon as the pitch is known these values become fixed. As a result of practice the length and depth of teeth for good working proportions, may be assured, while the thickness is at once fixed by the circular pitch.

Before porceeding to the actual design of a definite gearing where the proportions of the teeth will be completely worked out, we shall take up the consideration of the involute system of tooth outline. It will then be possible to carry both applications through at once and to make some interesting comparisons.

HEAT VALUE OF FUEL OIL.

R. F. CHEVALIER.

The commercial value of fuel depend upon:

1. Its available heat units.
2. The cost of mining and transportation to the market.
3. The cost of handling, and if machinery is used, the maintenance cost of same to stoke the fuel.
4. The cost of furnace up-keep.

The advantage of oil over coal as a fuel for the Pacific Coast has been discussed so often, both in first cost of the fuel and cheapness of handling, that it is not necessary to go into these oft-repeated details As there has always been a question as to how many barrels of oil are equivalent to a ton of coal, it is not amiss to reproduce the following article on the "Relative Values of Oil and Coal Fuel," published by the writer in the Journal of Electricity, Power and Gas, May 9, 1908:

The relative commercial value existing between coal and oil as fuel, irrespective of the cost of handling, is shown by the following data. This data is taken from tests made on the same type of boilers (Parker water-tube). The test on the boiler using coal was conducted by Prof. H. W. Spangler, at the Philadelphia Rapid Transit Company, Philadelphia. The test on the boiler using oil as fuel was made by the writer at Tubbs Cordage Company, San Francisco.

The data respecting the oil fuel were taken from one of a series of tests, and show the maximum efficiency obtained with the boiler under commercial operating conditions and a variable load.

As the rating of the boiler using coal is 700 (boiler) h.p., and that of the one using oil only 200 (boiler) h.p., naturally the highest efficiency would be obtained with the former; thus coal is favored. The coal-burning boiler was equipped with a mechanical stoker; and it is interesting to note the relative amount of steam used to operate the stoker, and that used by the burner to atomize the oil.

It is also interesting to note the comparison of the composition of the gases of combustion and the per cent of excess air above the amount theoretically required for perfect combustion by the different fuels. The per cent of builder's rating developed was practically the same, and the steam was superheated in both instances.

The coal used was fine anthracite. The oil was California crude oil as sold by the Standard Oil Company for fuel purposes, and from which the lighter hydro-carbons had been distilled. The heat value and other data pertaining to the fuel, as well as a comparison of the results and efficiencies obtained with the same, are shown in the following tabulation:

Fuel.	Coal.	Oil.
Gravity of oil, Baume		16.2°
Per cent of moisture in fuel	3.9	1.5
Per cent of ash	17.87	
Calorific value, by Parr Calorimeter, per pound of dry fuel, B. T. U.	11,811.	18,099.
Boiler Horsepower.		
Horsepower developed, A. S. M. E. rating.	832.3	241.
Builder's rated horsepower	700.	200.
Per cent of builder's rating developed	118.9	120.
Economic Results.		
Water apparently evaporated under actual conditions per pound of fuel	7.118	13.12
Equivalent evaporation, F. & A., 212° F. per pound of fuel	9.0767	15.11
Same per pound of dry fuel	9.4451	15.34
Same per pound of combustible	11.83	15.34
Efficiency.		
Efficiency of boiler	82.76	81.8
Per cent of steam generated used by stoker	5.8.	
By burner		3.58
Analysis of Dry Gases by Volume.		
Carbon dioxide	7.82	14.6
Oxygen	7.50	1.2
Carbon monoxide	.13	.00
Nitrogen	84.55	84.2
Per cent of excess air above amount theoretically required	50.	5.6

Assuming the cost of coal to be $4.00 per long ton, and the cost of oil to be $1.00 per barrel, the following comparisons can be deducted:

From the results as above tabulated we have an evaporation of 122.4 pounds of water per gallon of oil, cost of this gallon being $0.024. An equivalent evaporation required 12.96 pounds of coal at a cost of $0.023. This places the fuel value of oil at $0.023 per gallon, or $0.96 per barrel of 42 gallons.

Making further deductions from the above figures, we find that a barrel of oil is evaporating 5140 pounds of water; 544 pounds of the above coal were required to do the same work. Therefore, a long ton of such coal would be equivalent to 4.12 barrels of oil.

From various other data, the writer has found that the relative values of the two fuels bear approximately the same ratio.

PHYSICAL PROPERTIES OF FUEL OILS

KIND	Gravity at 60° F.		Flash Point	Water Contained, Per Cent.		British Thermal Units Oil Corrected for Moisture.	
	Specific	Beaume	Deg. F.	By Gasoline	By Distillation	Per Pound	Per Barrel
Bakersfield crude	.9683	14.5	Over 200	4.5	9.6	17858	6054397
Bakersfield crude	.9687	14.56	Over 200	2.0	4.5	17849	6051864
Treated oil	.9642	15.2	290	...	0.2	19040	6426000
Mixture of Coalinga and Bakersfield crude	.9635	15.31	228	...	0.3	18725	6314075
Treated oil	.963	15.37	258	...	0.3	18699	6301731
Treated oil	.9623	15.49	275	...	0.1	18782	6325777
Treated oil	.9594	16.2	...	...	1.5	18100	6077980
_____	.951	17.2	220	...	1.7	18213	6061452
Coalinga crude	.949	17.5	185	0.2	1.2	18990	6304680
Crude oil	.9485	17.6	155	0.2	3.5	18553	6159596
Crude oil	.9394	19.03	90	...	7.4	18412	6053681
Crude oil	.9192	22.3	78	0.75	7.0	18923	6083933

Table No. 1.

The relative values of the oils from different districts, and those of different specific gravity is a matter that often causes discussion. Those who have light oils to sell maintain that a pound of their oil has greater heat value than the heavier oils. This as a rule is true, but as oil is bought by volume instead of weight, a barrel of the heavier oil may contain as many heat units as the lighter oil. Specific gravity bears no necessary relation to the heat value, as oils of the same gravity vary considerably in heat units.

In table No. 1 will be found the physical properties and the heat values of various oils, so that the reader may draw his own conclusions. All determinations on these samples were made in the writer's laboratory.

From these data it is seen that we have two kinds of oil fuel—one in the natural or crude state, the other which has been treated in the refinery. The quality and physical properties of the former are more liable to vary. The gravity and heat value have a wide range, and the water contained is considerable. In many instances the writer has found as high as 10% of water in crude oil sold as fuel. The average is between 3 and 6%.

On the other hand, when oil is treated it is heated in the still to a temperature much above the boiling point of water. The water in the oil passes over with the distillate, leaving a moisture free oil to be used as fuel.

(To be continued.)

TRACKLESS TROLLEYS IN AUSTRIA.

A number of letters having been received asking for information regarding the trackless trolley lines in operation in Austria, Vice-Consul-General R. W. Heingartner of Vienna has gathered the following facts:

The Stoll trackless trolley system is the invention of Herr Ludwig Stoll of Vienna, a leading official of the Austrian Daimler Motor Company. The system has for some time been worked successfully near Vienna and elsewhere in Austria-Hungary. Current is taken from the overhead positive wire by flexible cables, and not by a pole or boom. Instead of an underrunning wheel or overrunning shoe, the head or actual current collector is a frame with two small grooved wheels on each side. One pair of wheels runs on the positive, the other on the negative wire, and the cable is suspended from the center of the frame, from which point also is suspended a weighted pendulum, which keeps the wheels well pressed down on the wires. The wheels (or pulleys) run on ball bearings. The trolley runs without sparking. The pull of the cable acting on a very short lever arm, and the center of gravity of the trolley being low, no deviation of the trolley is possible, even in strong transverse pulls. The conducting cable can be lengthened to follow the car by two appliances—an upper sliding knot tied up on the pendulum weight and stretched by a string in the latter, and a cable roller (on the left) with 10 to 12 yards of cable, which can be rolled up or let out by a spiral spring. Thus the car is allowed to run on any part of the road, to overtake other carriages, or to turn anywhere, accommodating itself to all kinds of traffic.

When two cars running in opposite directions meet, the drivers interchange the trolley conduits by detachable contact boxes, an important advantage over a tram line with one track, on which the loss of time in waiting at passing places is sometimes considerable. The vehicle having this flexible means of taking the current can, it is stated, move as far as 20 meters (65 feet) away from the wire, and thus has powers of adaptability which would be rarely exercised to the full extent.

The chassis of the vehicles for transport of passengers or goods is made of pressed steel and is supported on the axles by springs. The brakes act on the back wheels. The electrical part comprises a controller of tramway pattern, resistances, and two motors of 20 horsepower each, which really form an integral part of the driving wheels themselves on the Lohner-Porsche principle. There are no other mechanical parts of control or transmission; it is, therefore, very simple. Hardly any lubrication is required, all the parts of the wheels and motors running on ball bearings. Further, the elasticity of the vehicle itself is considerable, as the springs support only the chassis, the body, and the passengers, but no engine, batteries, or transmission gear, there being none of these mechanical complications. The suspension, therefore, is perfect, and notwithstanding the imperfections of the road, gives the impression of moving on rails. Vehicles carrying 3000 kilos (6600 pounds) and over have back wheels with iron tires. The cable transmitting the current passes through the interior of the axle. The armature of the motor is fixed by means of keys on the axle itself, and so acts as the nave of the wheel. The rest of the wheel is mounted on an ordinary motor on ball bearings, and is completely protected from dust. The cover serves to hermetically close the motor, as well as to fix it on the axle. Solid rubber tires are fitted to absorb the inequalities of the road.

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FOUNDED 1887 AS THE
PACIFIC LUMBERMAN, CONTRACTOR AND ELECTRICIAN

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Electricity in Mining

Of all the multifarious uses to which the greatest modern servant of mankind—electricity—has lent itself, there are probably none more productive of greater economies, conveniences and factors leading towards human safety than is its application to mining.

In its subtle, silent way, electricity has invaded every realm of the miner's kingdom and has superseded him with his clumsy hand tools and slow, laborious methods. While it is true that this supersession has not, as yet, become universal, nor is it in all its applications entirely successful, still the operation of the modern mine has become so dependent upon the electric current that the mine which at the present time does not utilize it in some form seems a relic of antiquity.

The electric drill, while at the present time not an acknowledged success, is far ahead of the old four-pound hammer with its companion, the sunflower-headed hand drill, while electric ignition of blasts has removed the great element of risk to human life so often accompanying the old cap and fuse method. The patient, plodding mule has given way to the electric locomotive; the squeaking windlass or circling whim to the hoisting motor.

The old steam-driven Cornish pumps are supplanted by the modern high-speed motor-driven multi-stage centrifugal; the time-honored candle in the miner's cap to the incandescent bulb; the grinding arastra, or shaft-driven stamp mill, have submitted, the one to obsolescence, the other to unification and subdivision.

While not superseding a former procedure, the intercommunicating telephone has reduced delays and exasperating mistakes, to say nothing of the increased safety it affords those underground.

In the present article on the subject, by Mr. Shoemaker, we are ably introduced to the myriad points and kinks which are gained only through years of experience in adaptation. Indeed, the paper affords much of the "unwritten law" of this branch of engineering.

It is rare that one in the possession of such a fund of practical knowledge on a subject can be induced to transmit it so fully to his fellow-engineers. May the example of Mr. Shoemaker inspire many others possessed of the "secrets of the trade" to the same philanthropic action.

Building up the Coast Region

All the Pacific Coast needs to increase in prosperity, population, production and industry, is to make its resources known to all the world in the right way. The Pacific Coast will increase vastly within the next decade, and within a few decades will surely outstrip the Atlantic Coast in everything that goes to make up modern business and civilization. Doubtless in the Pacific States region, and at no distant date, the greatest Anglo-Saxon settlement that the world has ever known will have found an abiding place and scope for its indomitable energies. The supremacy of the commerce of the Pacific involves nothing detrimental to the prosperity of the Atlantic Coast, and indeed will accentuate the progress and that of the whole United States.

WESTINGHOUSE NEW VICE-PRESIDENT.

Mr. Henry D. Shute was appointed to the position of acting vice-president of the Westinghouse Electric & Manufacturing Company as of April 1, 1910.

For seventeen years Mr. Shute has been associated with this company, and his promotions from time to time have been of a character to give him a broad experience in shop, sales and executive work.

Mr. Shute studied electrical engineering at the Massachusetts Institute of Technology, from which institute he was graduated in 1892. Following his graduation, he spent a year's study in Germany at the School of Mines, Clausthal, and also in Dresden. It was in 1893 he entered the works of the Westinghouse Company at Pittsburg as an apprentice, spending his first two years in the testing department, following which he spent considerable time on erection work,

Henry D. Shute.

on laboratory work, under Mr. C. F. Scott, and later as assistant foreman of one of the departments of the works. This naturally gave him a broad experience in shop work, which, with the designing work on alternating current apparatus which he subsequently took up in the engineering department, enlarged his experience still more.

After five years' service with the company, Mr. Shute took up work in connection with the sales department at the East Pittsburg office, and in 1901 was made the head of the alternating current division, correspondence department. Two years later he was advanced to the position of assistant to Vice-President L. A. Osborne, which position he held at the time of his recent appointment. In this latter position he was active in the developments made in heavy electric traction and particularly in single-phase railway work.

Mr. Shute is a member of the American Institute of Electrical Engineers; a member of the Engineers' Club of New York, and most of Pittsburg's business and social clubs.

TRADE CATALOGUES.

The Fort Wayne Engineering & Manufacturing Company, Fort Wayne, Ind., have issued a bulletin describing the Paul pneumatic pressure system of water supply, giving description of direct-connected motor-driven pumps. The application of this system includes residences, hotels, fire-protection service, water-softening plants, etc. The bulletin is entitled "Pumping Machinery," and can be obtained from any of the offices of the Fort Wayne Electric Works.

PERSONALS.

A. G. Wishon of Fresno, who has electric power interests in Southern California, is a visitor in San Francisco.

Sidney Sprout, electrical engineer, has just returned from a business trip to Los Angeles and surrounding territory.

Thomas Collins of the Westinghouse Electric & Manufacturing Company's sales force is making a trip to Eureka.

W. H. Hill, who is interested in the Monterey County Gas & Electric Company of Monterey, was a recent visitor in San Francisco.

W. J. Davis Jr., Pacific Coast engineer for the General Electric Company, recently returned to San Francisco after visiting the Schenectady factory.

H. G. Stott of New York, who has been in Los Angeles on electrical engineering business, passed through San Francisco last week on his way East.

W. S. Heger, Pacific Coast manager for the Allis-Chalmers Company, left San Francisco last week on a short business trip to the factory in Milwaukee, Wis.

Thomas Mirk, of Hunt, Mirk & Co., representing the Westinghouse Machine Company on the Coast, has gone to Los Angeles on steam turbine business.

R. Husbands, manager of Pierson, Roeding & Co.'s Seattle office, returned to Puget Sound during the week after visiting the main office of the firm in San Francisco.

H. D. Boschken, manager of the California Electrical Construction Company's San Jose branch, visited the main office in San Francisco during the past week.

Edward G. Dewald of the San Francisco office of the Allis-Chalmers Company left for the Pacific Northwest last week on business with the hydraulic turbine department.

H. P. Wilson, secretary of the Great Western Power Company, arrived in San Francisco from New York during the past week on important business connected with local banking interests.

W. J. Krase, erecting engineer for the Pelton Water Wheel Company, is at Gateway, Utah., in connection with the installing of the new hydro-electric plant of the Utah Light & Railway Company.

Mr. Herbert Rice, general sales manager The Cutter Company, Philadelphia, was in San Francisco last week on his annual visit to their agencies throughout the West. He left for Portland Thursday.

A. L. Bell, a son of Professor Alexander Graham Bell, inventor of the Bell telephone, and S. F. B. Morse Jr., a son of Professor S. F. B. Morse, the father of telegraphy, recently visited San Francisco.

C. A. Coffin, president of the General Electric Company of New York, has returned to Southern California after spending a few days in San Francisco as the guest of Doctor Thomas Addison, the district manager.

C. L. Cory has returned from a trip to Santa Barbara in connection with his report to the municipality as to the cost of producing gas. He is now working on a similar report in connection with fixing the rates for electric light and power in Santa Barbara.

W. B. Southwick, who is manager of the United Wireless Telegraph Company's Seattle office, has returned to Puget Sound after spending some days in San Francisco in connection with the installing of wireless apparatus on steamers of the Pacific Mail Company.

E. A. Davis of New York, who is a guest at the Fairmont Hotel, is credited by local publications with representing the Continental Trust Company of New York in successful negotiations for the purchase of the control of the Key Route electric railway and ferryboat system connecting Oakland and Berkeley with San Francisco.

INDUSTRIAL

BOILER FEED REGULATION.

Progress in mechanical industries has been closely allied with the invention and perfection of automatic devices of all forms. In the railroad field, we find that heavy freight traffic and high-speed passenger service was made possible by the air-brake. Among the improvements in stationary steam plants the automatic governors have probably contributed more toward reliable operation and increased output, than any other single device. In the electrical field, proper, we find automatic voltage regulators, circuit breakers, and other devices which not only make operation more reliable and safe, but cut down the cost of attendance.

It would thus seem that inasmuch as the boiler is primarily the seat of power in any plant, it should be equipped with the best and most up-to-date automatic devices. Next to the safety valve, with which all boilers are equipped, it appears that the next step in the line of progress should be the installation of apparatus which will insure a constant water-level in the boiler under all conditions of operation. Then, again, the increasing demand for higher steaming capacity, conservation of fuel, and reliable service necessitates that the rate at which water is fed into a boiler be equal to the rate of evaporation. This necessity for constant water-level has been realized by progressive engineers and is ably summed up by Prof. Kent, as follows:

"Steadiness of water-level requires either a large area of water-surface and volume of water, so that the level may be changed slowly by fluctuations in the demand for steam or in the delivery of the feed pump, or else constant and preferably automatic regulation of the feed water supply to suit the steam demand. A rapidly lowering water-level is apt to expose dry sheets or tubes to the action of the hot gases, and thus be a source of danger. A rapidly rising level may, before it is seen by the fireman, cause water to be carried over into the steam pipe, and endanger the engine."

The advantages of automatic regulation of boiler feed and the maintenance of a constant water-level may be briefly summed up as follows:

1. The boilers are insured against low water and all danger of bagging and burning of tubes or boiler plates is practically eliminated.

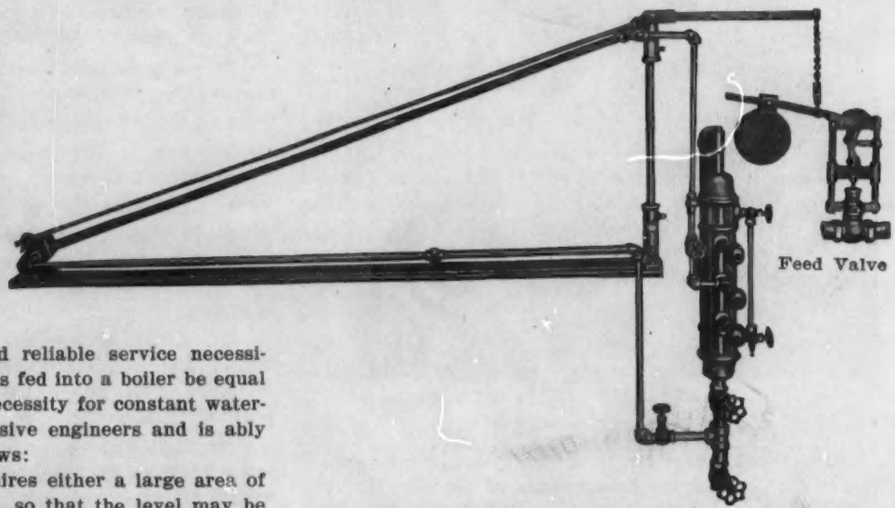
2. The heat saving economies of feed water heaters and fuel economizers are greatly augmented as the flow of water through them is maintained about equal to the amount of waste heat furnished to them. This point is clearly brought out by the two charts shown herewith from which it will be noted that the average temperature of the feed water after the installation of an automatic boiler feed regulator is considerably higher than it was before. This is due to the fact that as a load comes on the plant and consequently the engine is exhausting more steam into the heater, there is of course a correspondingly greater demand on the boiler, and as the feed water regulator is very sensitive it immediately opens the feed valve increasing the flow of water to the boiler and through the heaters. Thus, every time there is an excess of steam blown into the heater there is also an additional quantity of the water passed through into the boiler.

3. The danger from priming is greatly reduced, thus saving cylinder lubricant and lessening the frictional wear between valves and seats, and piston and cylinder, due to the better lubrication possible with dry steams.

4. The life of turbine blades is greatly increased as errosion due to wet steam is eliminated.

5. Superheaters have higher efficiency as they are supplied with dry steam and their only duty becomes that of superheating, also scale-forming materials are prevented from being carried over into them, thus eliminating the cost of cleaning.

6. Operating expenses are greatly reduced as less boiler room attendance is required. All the fireman has to do is to fire, his attention need not be distracted by watching the water gauge.



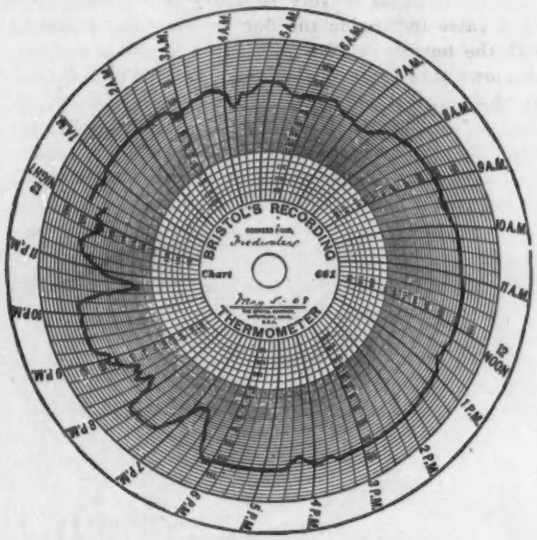
Copes Boiler Feed Regulator attached to the water column of a boiler. The Regulator may be placed at any distance from the boiler by using longer connecting pipes. The feed valve may also be at any distance from the Regulator, but the eye of the toggle arm must be directly below the outer eye of the upper regulator arm, that is, the chain must occupy a vertical position.

The Copes regulator, which is illustrated in Fig. 2, has ingeniously adapted the principle of expansion and contraction of metal, under the influence of heat to the control of a boiler feed valve. As can be seen, the device is simple in its construction and is completely external to the boiler. The expansion member, consisting of a copper tube, is at one end in communication with the point on the water column corresponding to the desired water-level in the boiler, and at the other end to any convenient place below the water-level. Thus, when the water in the boiler is low the expansion tube is filled with steam, and when the water in the boiler is high, the expansion tube is cut off from the steam supply and as the steam within it condenses, due to radiation, it fills up with water. When steam is in the tube, there is a continual supply of heat and therefore the tube is kept at a temperature equal to that of the steam. When the steam supply is cut off, however, the tube is filled with water, which, by giving up its heat to supply radiation losses, experiences a temperature drop which causes the tube to contract, operating the feed valve mechanism.

The regulator tube might well be compared to a common steam radiator, which, even in the coldest weather, does not cool off so long as the supply of steam is continual. However just as soon as the valve is shut off and the steam allowed to condense, the radiator cools off. When the Copes tube is

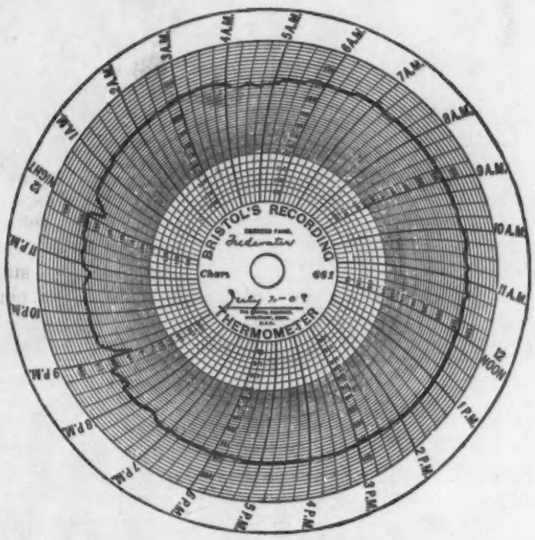
full of water, there is some circulation, but this is nowhere near fast enough to make up for the radiation loss and keep the tube hot. This has been proved by experiment many times.

While this motion, due to expansion and contraction, is



Showing daily variations, in the temperature of boiler feed water from Cochrane Heater, due to irregularity of feeding, before Copes Regulator was installed.

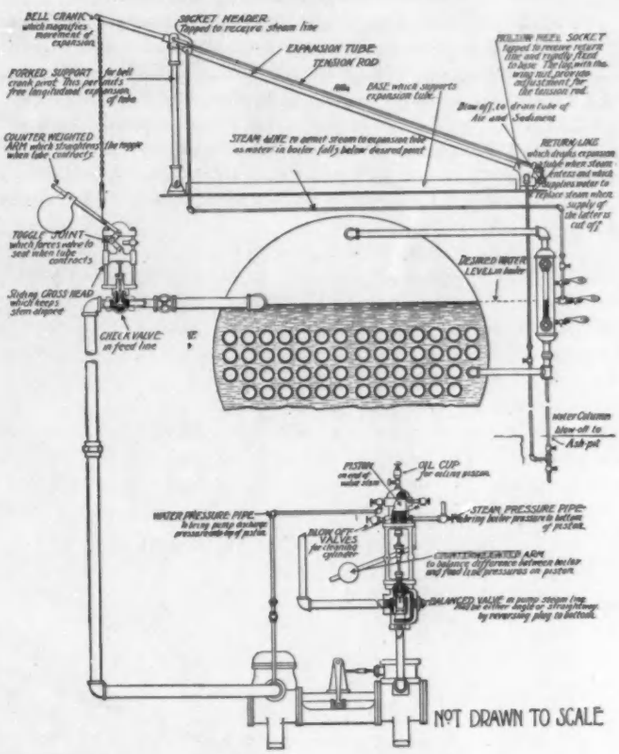
positive and reliable, it is not sufficient to actuate the feed valve directly. For this reason a very simple system of levers magnifies and transmits this motion to the feed valve. As can be seen by reference to the figure, the expansion of the tube operates a bell crank lever, which, in turn, lifts a weighted lever by means of a chain, thereby actuating a toggle joint which permits an ordinary check valve to open.



Showing uniformity of feed water temperature after Copes Regulator was installed to hold inflow of feed just equal to evaporation at all times. Increased area of chart represents coal saved. See page 13.

The action on contraction is the reverse, that is, the chain slacks off and the feed valve is closed by the weight. It is to be noticed that the valve employed is in every respect a check valve, as it is not permanently connected to the valve stem of the regulator. In fact, this valve is accepted by boiler inspectors in place of the ordinary boiler check valve.

It is interesting to note that the Copes regulator requires no auxiliary water columns, or float chambers, neither does it necessitate the boring of holes in the boiler shell, in fact the work of installing this regulator requires only a small amount of pipe fitting which can be done in a short time.


BELL CRANK
which magnifies movement of expansion.
SOCKET HEADER
Tapped to receive steam line
EXPANSION TUBE
TENSION ROD
FORKED SUPPORT
for bell crank pivot. This permits free longitudinal expansion of tube.
BASE which supports expansion tube.
Blow off, to drain tube of air and Sediment
COUNTER WEIGHTED ARM which straightens the toggle when tube contracts
STEAM LINE to admit steam to expansion tube as water in boiler falls below desired point
RETURN LINE
TOGGLE JOINT
which forces valve to seat when tube contracts
DESIRED WATER LEVEL in boiler
Sliding CROSS HEAD
which keeps stem aligned
CHECK VALVE
on feed line
Water Column blow off to Ash pit
PISTON
OIL CUP
for oiling piston.
WATER PRESSURE PIPE
STEAM PRESSURE PIPE
BLOW OFF VALVES
for cleaning cylinder
COUNTERWEIGHTED ARM
to balance difference between water and steam head pressures on piston.
BALANCED VALVE
NOT DRAWN TO SCALE

There is only one packed joint and that is at the valve stem, hence there is no danger of leakage and as no floats or diaphragms, which are liable to collapse, or piston or pilot valves, which cut out due to wire-drawing, are used, the whole apparatus is extremely simple and reliable.

The Copes regulator is manufactured by the Northern Equipment Company of Chicago, Ill., the general Pacific Coast agents being Chas. C. Moore & Co., engineers, of San Francisco.

SAN FRANCISCO ENGINEERS HOLD ANNUAL BALL.

On Saturday evening, April 2d, an enjoyable affair was participated in by a large number of San Francisco engineers and their wives and families. The event was the first annual ball given under the auspices of the N. A. S. E. of San Francisco, and as the committee in charge was composed of the former Fair and State Convention Committee of 1909, five members being appointed from each of the two subordinate associations, California No. 1 and No. 3, it could not be otherwise than a grand success. The ball was held in the Auditorium Annex, which was comfortably filled and the dancing was continued until 1 a. m.

Director John W. Carter acquitted himself of his arduous duties ably, as did all the other members of the committee, assisted by the floor committee. Charley Elsasser, the versatile, even wresting the baton from the genial Prof. Ehrman and conducting the orchestra while playing a rollicking two-step, which was punctuated by the accompaniment of a number of shots from a blank cartridge pistol, which made some of the thirsty ones at the refreshment stand think that a gauge glass had broken.

Many of the throttle wielders had not done a stroke of dancing in twenty years, but they were game, and covered themselves with glory, likewise perspiration. Bro. John

Traynor never missed a number despite his decrepitude. The bunch, as is their usual custom, congregated in close proximity to the bar, and swapped Sunday school story reminiscences and drank pink lemonade.

The feminine portion of the gathering were well pleased, as no cold feet were discernible among the engineers; every one, old and young, doing their best to see that no ladies sat out any of the dances, and when Prof. Ehrman laid down his baton after playing "Home, Sweet Home," everyone conceded that the affair was thoroughly enjoyable, and hoped the committee would take steps to make the affair an annual one.

Bro. Phil Ennor, President of California No. 1, in his usual happy manner, addressed the audience and explained the object of the ball, which was to bring the families of the members together, and thus cement the feeling of goodfellowship and fraternity which exists between the members of California No. 1 and No. 3.

Among those present were the committee of arrangements; Bro. B. E. George, chairman; J. W. Carter, John Traynor, C. C. Elsasser, W. M. Jenkins, John W. Maher, W. T. Bonney, J. L. Davis, Charles Dick, treasurer, and H. W. Noethig, secretary.

Floor Committee—John Carter, director; A. C. Arbuckle, J. B. Williams, Clyde D. Johnson, David Thomas, Frank Tuttle and J. G. De Remer.

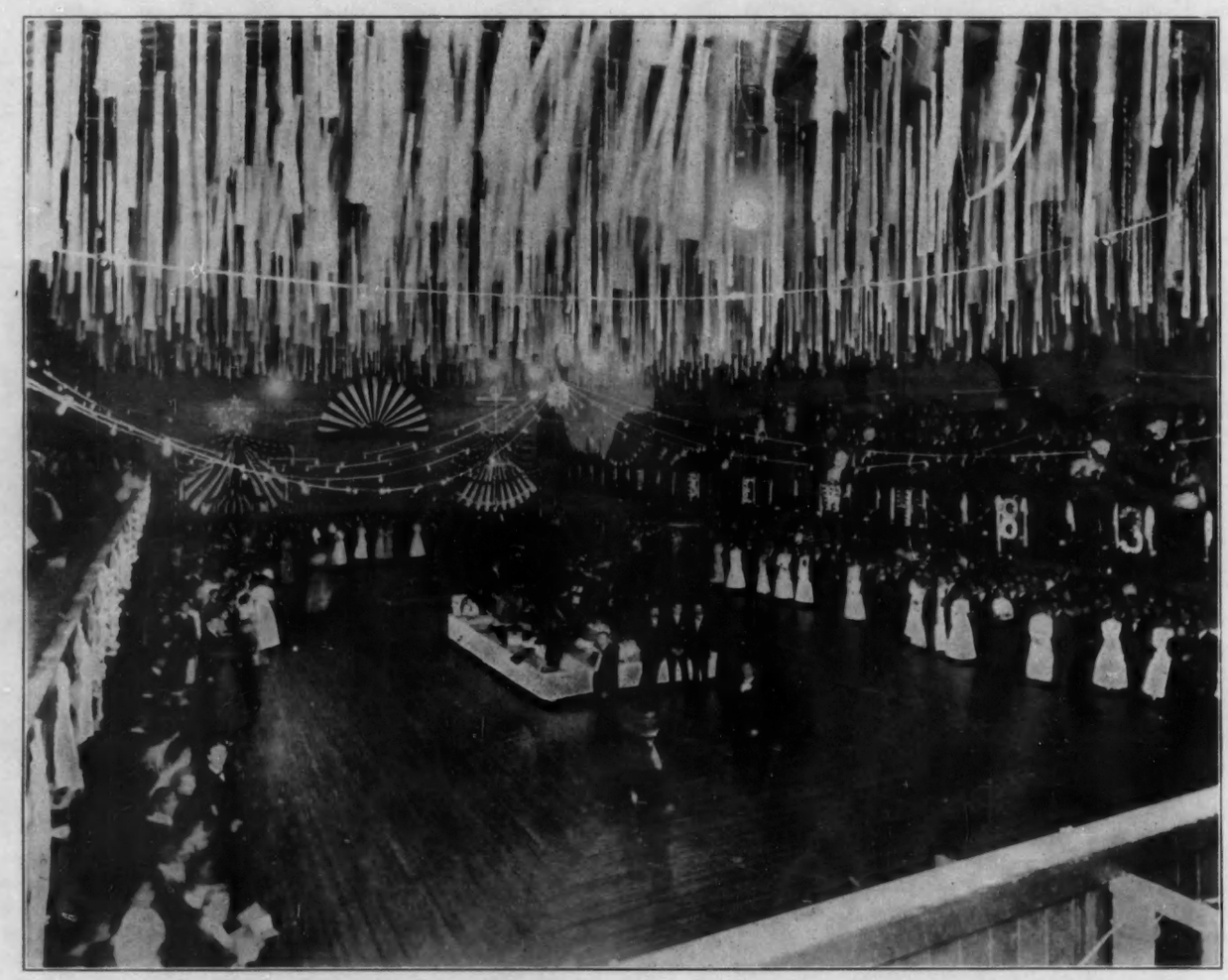
Bros. W. P. Millner, H. D. Saville, James B. Castle, Dan Daniels, J. Richards, L. W. Holbrook, C. E. Van Meter, W. N. Munro, J. B. Green, Charles Knights, P. Reardon, M. Nelson, J. Ostrom, W. T. Carroll, J. Gaskill, Alex McDonald and a host of other engineers and friends, too numerous to mention. Almost all were accompanied by their wives or some other engineer's wife and all voted that the affair was the most joyous in the annals of the N. A. S. E. in San Francisco.

DAVID THOMAS,
Recording Secy. Cal. No. 3, N. A. S. E.
439 Merchants' Exchange Bldg., San Francisco, Cal.

ELECTRICAL WORKERS' BALL AT TACOMA.

The accompanying illustration was taken at the third annual ball given by Local 483 of the International Brotherhood of Electrical Workers, at the Armory, Tacoma, Wash., March 17, 1910. This was one of the largest balls ever held in that city, the attendance being about 4000.

The illumination consisted of eight Grant flaming arcs having a c.p. of 40,000; 1000 16-c.p. incandescent lamps festooned as shown in the photograph, and two spot lamps. At the north end of the hall were a 6-ft. star and a 9-ft. anchor outlined by means of incandescent lamps. Between the anchor and the star was a set piece representing the sun rising over hills. To the right of the anchor was a moving picture machine which threw the dance numbers upon the canvas. Along the right-hand balcony was outlined by means of incandescent lamps "I. B. E. W.—483"; along the left-hand balcony outlined in the same manner, "Welcome." At the end of the hall, not shown in the photograph, were the spot lamps, a set piece 4 x 6 ft. representing the American flag and a flasher showing the emblem of the I. B. E. W. The color scheme was green and white. The green and white crepe paper suspended from the beams together with tinsel cord about every 4 ft. made quite a pleasing effect. The committee on decorations consisted of J. T. Riley (chairman), George Osborn and S. V. Peterson.



I. B. E. W. Ball at Tacoma, Wash.

SOUTHERN CONVENTION OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

Special Correspondence.

A special convention of the American Institute of Electrical Engineers was held in Charlotte, N. C., March 30th and 31st and April 1st. This is the first of a series of conventions or meetings which, it is hoped, will be held in different sections of the country from time to time, but which are not intended to take the place of the annual conventions.

Headquarters were at the Selwyn Hotel and over three hundred visitors, members and guests were registered, altogether, about 550 names being on the list of those in attendance.

The first meeting was held at 2:30 p. m. Wednesday. After being warmly welcomed to Charlotte by Mayor T. W. Hawkins, who was thanked, on behalf of the Institute, by President L. B. Stillwell, a paper on "Electric Drive in Textile Mills" by Albert Milmow was read.

In the discussion, in which C. F .Scott, W. S. Lee, A. W. Henshaw and D. B. Rushmore took part, it was pointed out that the greatest gains from the electric drive are usually incidental; that is, the improved steadiness of the drive, which permits of a higher speed with improved quality of product and increased output, are more important than reduced cost for power. The curves given in the paper bring this feature out clearly. Moreover, the electric drive is flexible and makes possible the best arrangement of the machines without respect to the driving power. Also, extensions are easily made. The function of the electric service is the supplying of power, and in general it is better for the mill to buy its power, as it does its other supplies, than to make it.

E. D. Latler Jr. read a paper entitled "Gas Engines in City Railway and Light Service." There was no discussion on this paper. After the meeting visits were made to various textile mills and to the gas engine station described in the above paper.

Wednesday evening E. E. F. Creighton gave an experimental lecture, illustrating the characteristics of various types of lightning arresters.

Thursday morning the second session was held, when Carle Hering read abstracts of his paper on "The Proportioning of Electrodes for Furnaces," and of Dr. A. E. Kennelly's paper on "Modifications of Hering's Laws of Furnace Electrodes." Mr. Hering discussed briefly Dr. Kennelly's paper and read a short discussion thereon.

W. S. Lee read a paper entitled "Economies of Hydro-electric Plants." This paper was discussed by C. E. Wachdell, P. H. Thomas, C. Hering, E. W. Shedd, L. B. Stillwell, W. L. Waters and R. W. Pope. It was pointed out that power companies should have the right of eminent domain, now enjoyed by railroads; that one large system gives better service than several smaller ones Certain utilities are natural monopolies and the public should be educated to recognize them as such; unjust rates can be prevented by the State, which now has that right. It was suggested that a night load might be built up if electric roads should be built upon which freight might be hauled after the mill load has gone off. It was suggested that the induction generator would be a suitable machine for systems where many stations are operated in parallel, the magnetizing current for these machines being furnished by the charging current of the line. There are a number of electro-chemical and metallurgical processes which could profitably use the intermittent overflow power of hydro-electric systems.

Thursday afternoon L. C. Nicholson read a paper entitled "A Method of Protecting Insulators From Lightning and Power Arc Effects With Results of Its Installation on the Lines of the Niagara and Lockport Power Company." This paper was discussed by P. H. Thomas, J. W. Fraser, E. B. Merrian, C. F. Scott, J. A. Sanford Jr. and others. It was suggested that one possible means of overcoming most of the insulator troubles would be to increase the factor of safety. This method had cured transformer troubles. The disadvantages of short interruptions should not be magnified. The ground wire had not yet been proved valueless and two ground wires would be better than one as lightning at times comes in from the side.

Written communications were received from Professor Harris J. Ryan, James Lyman and S. V. Brooks, but were not read due to the latness of the hour. Professor Ryan suggested shields and barrier plates to prevent damage to the line when an arc occurs.

During Thursday afternoon the visiting ladies were entertained by Mrs. Stuart W. Cramer, and in the evening a brilliant reception and dance were given at the Auditorium.

Friday was given up to a trip to the Great Falls and Rocky Creek stations of the Southern Power Company, the Institute being the guests of the company. A special train carried the party of 400 to the power sites and after the inspection an old-fashioned barbecue was given the company. H.

TRADE NOTES.

The People's Light & Power Company has just secured its franchise for Alameda county on a bid of $100, the threatened opposition not having materialized. The Great Western Power Company's current will be distributed by this concern through portions of the county outside of the city of Oakland, including Fruitvale, Elmhurst, San Leandro and Haywards.

R. S. Buck, a member of the firm of Sanderson & Porter, has just arrived in San Francisco from New York. He expects to make quite a stay here in connection with the completion of the Sierra & San Francisco Power Company's Stanislaus river development. The announcement of the starting up of the fourth 6750-kw. generating unit, at the main power plant near Vallecito, is expected soon. M. C. McKay, the station superintendent, has been installing the new equipment.

Carl Bauer, one of the turbine wheel designers from the Pelton Water Wheel Company's New York office, is now at Gateway, Utah, supervising the installation of the 5000-h.p. Pelton-Francis turbine for the Utah Light & Railway Company. This is a new auxiliary plant located about fifteen miles from Ogden and it will tie in with the Salt Lake system. The new water wheel will be direct connected to a Western Electric generator and will operate under a head of approximately 138 ft. at 300 r.p.m. A Pelton oil-pressure governor, of Pelton type, will be used.

The General Electric Company has sold to the Sierra & San Francisco Power Company, in connection with the extensive changes in the United Railroads system in San Francisco, a 9000-kw. (maximum rated), 60-cycle vertical steam-turbine generator with condenser base. It will be installed in the United Railroads' North Beach power station. The present 5000-kw. steam-turbine set at the United Railroads' North Beach station will later have a new generator installed, with a maximum capacity of 9000 kw. This load can be carried continuously.

The largest contract for mining and ore-reduction machinery let since the panic has just been closed by the Allis-Chalmers Company, through its London office, with the Union Miniere du Haut Katanga of Brussels, Belgium. This comprises every detail of the crushing, concentrating and smelting equipment for a copper-producing plant of 900,000 tons yearly capacity, including power house and electrical equipment to be built near Lake Tanganyika in the Congo territory of central Africa. This order, which covers one of the largest and most perfectly equipped mining plants in the world, was obtained in a wide competition because of the unique ability of an American company to supply all the machinery under a single contract.

NEWS NOTES

FINANCIAL.

PORTLAND, ORE.—Fire Chief Campbell and Engineer D. D. Clarke, of the Water Department, are considering plans for the expenditure of $275,000 bonds to be sold in providing for a fireboat and re-enforcing water mains for the protection of the business district.

FRESNO, CAL.—Sealed bids will be received by the Clerk of the Board of Supervisors up to 11 a. m., April 23, 1910, for the sale of a franchise for a street and interurban railroad over, along and across certain streets and highways in Fresno County. The application was made by the Fresno Traction Company.

SAN FRANCISCO, CAL.—W. R. Hagerty, Clerk of the Supervisors, has received word from Dillon & Hubbard, the New York attorneys who haxe examined former bond issues for the city, saying that they will examine and pass upon the validity of the $45,000,000 proposed water bond issue for the sum of $20,000.

EL CENTRO, CAL.—The City Council passed an ordinance providing for the issuance and sale of the interest bearing bonds of the city of El Centro in the amount of $69,000, for the purpose of the acquisition, constructing and completing of a municipal water works and water system for supplying water to the city.

INCORPORATIONS.

SEATTLE, WASH.—The Bothell Electric Company, of Seattle, Wash., with a capital stock of $25,000, has been incorporated by C. W. Kimball, W. A. Garlick and A. R. Rutherford.

BAKERSFIELD, CAL.—The Twenty-three Water Company, with a capital stock of $10,000, has been incorporated by T. M. Young, B. L. Smith, J. B. Wrenn A. B. Canfield and A. L. Cheney.

BAKERSFIELD, CAL.—The Horton Electric Company, with a capital stock of $75,000, has been incorporated by J. B. Murdock, J. W. Ragesdale, C. C. Painter, R. E. Woods, H. E. Smith, J. A. Felter and A. A. McCumber.

STOCKTON, CAL.—The Stockton Terminal and Eastern Railroad has been incorporated by A. Shane of Indianapolis, W. H. Newell of Stockton, A. A. Grant of Sonora, M. J. Congdon, J. E. Adams and R. V. Dixon of Berkeley, and others.

ELLENSBURG, WASH.—The Ellensburg Oil & Gas Company has been incorporated by P. H. Ross, B. A. Gault, F. P. Wolff and Geo. R. Simpson, with a capital of $1,000,000. Work of drilling for oil on the old Bull ranch, near Thrall, will be resumed at once by the new company.

SACRAMENTO, CAL.—The California Northern Telephone and Telegraph Company, to operate in all parts of Northern California, has filed articles of incorporation. It is capitalized at $100,000 and the following are the directors: Scott Hendricks, San Francisco; W. H. Bissell, Livermore; W. E. Ellis, Arthur Mathews, Grant Smith, M. C. Colby and J. O. McElroy, all of San Francisco.

ELLENSBURG, WASH.—Articles of incorporation have been filed by the South End Water Company, with a capital of $12,000, with the principal place of business in this city. The objects of the company are to construct, operate, equip, maintain and renew a system for the supply of water to such parts of Ellensburg and the territory adjacent as it shall obtain franchise for. The incorporators are Geo. DeWees, Chas. Anderson and J. W. Gilliam.

TRANSMISSION.

SAN BERNARDINO, CAL.—The Edison Power Company is hauling many tons of cement into the Santa Ana Canyon, for repairs on the flumes and powerhouses damaged by the storms of the late fall. The company will also build a new power plant at Slide Lake, in the canyon, and $600,000 will be expended in this improvement.

ADIN CAL.—R. Perrault has filed on 5,000 inches of the water of Ash Creek, running from Ash Valley, in Lassen County, to Big Valley, in Modoc County. There is about a 600-ft. fall in about ten miles. This location has been chosen for a pipe line for electric power purposes, the power to be used at the Hayden Hill Mines, about six miles distant.

CHICO, CAL.—The Great Western Power Company will not this year construct the projected storage reservoir in Big Meadows. This statement is made by A. B. Bidwell, superintendent of the Big Meadows division of the power company. Superintendent Bidwell added that his company will take up the matter of establishing permanent headquarters in Big Meadows. The temporary headquarters have hitherto been at Bunnell's place, near Prattville. The new and permanent headquarters will be situated at the east end or outlet of the valley, at a point that has been known as Meadow View, but which will in the future be known as Nevis. The improvements at Nevis will consist of the restoration of the hotel and other buildings and the installation of a water system. As Nevis is the nearest point to the Western Pacific, as well as to the main construction work to be completed later on the new headquarters will be a place of considerable business importance. The construction work of the power company is now centered on the big dam near Big Meadows. The outlook is that the construction of the Big Meadows project will be long delayed, as the company has three sites along the North Fork of the Feather River, above Big Bend. These will probably be developed before the Big Meadows plans are carried out.

ILLUMINATION.

ORLAND, CAL.—The Northern California Power Company will soon start to build a sub-station on C. F. Hale's ranch for the power line which is to tap the company's Orland-Hamilton branch line.

GRANGEVILLE, IDAHO.—The Council has passed an ordinance granting a 30-year franchise to Walter Hovey Hill for the use of the streets and alleys of the city for the purpose of stringing wire over which to transmit an electric current.

MEDFORD, ORE.—The City Council has granted a 25-year gas franchise to J. R. Anderson, of Pasadena, for the erection of a gas plant in Medford. The plant is to be in operation within eight months from the date of the granting of the franchise.

PORTLAND, ORE.—According to information given out by C. E. Grosbeck, of San Diego Cal., vice-president of H. M. Byllesby & Co., of Chicago, five million dollars will be expended on improvements by the company to its northwestern gas, electric and telephone systems.

SAN LUIS OBISPO, CAL.—C. F. Hoffman has presented to the Board of Supervisors his application for a franchise for the term of 50 years, to lay gas pipes for the purpose of carrying gas for heat, light and power over and upon public highways in San Miquel Judicial Township in San Luis Obispo County. Sealed bids will be received by the Board of Supervisors up to 10 a. m. May 3, 1910, for the sale of this franchise.

LOS ANGELES, CAL.—The City Council passed an ordinance ordering necessary appliances to be installed and electric current to be furnished for a period of one year for the lighting of Pico street, between Main and Vermont avenue.

SIERRA MADRE, CAL.—The City Council passed an ordinance granting to C. S. S. Forney a franchise to construct, operate and maintain for a period of 50 years an underground conduit, mains and gas pipes in the public streets, for the purpose of conducting and carrying gas for light, heat and power.

NORTH YAKIMA, WASH.—E. Storer Tico, local manager of the Northwestern Corporation in North Yakima, has announced that the sum of $40,000 is to be expended by the company in doubling the size and capacity of the local gas plant and, in addition, about 12 miles of mains in the territory not now served with gas. New and enlarged machinery will be installed in the plant, new branches will be placed and new retorts erected. There will also be new compression tanks.

TENINO, WASH.—The Tenino Light, Power & Water Company is prepared to construct a dam and powerhouse, with an output of 2,000 hp., on the Skookumchuck River, 15 miles east of Tenino. The project calls for the expenditure of $200,000. Water will be transmitted to the turbines through a wood pipe 60 in. in diameter and 3,0007 ft. long, to have a fall of 174 ft. The dam will be built of concrete, reinforced with steel rails. S. W. Fenton, of Tenino, is the president of the company.

LEWISTON, IDAHO.—Plans are being perfected for the organization of the Craig Light & Power Company, of Vollmer, with a capital stock of $o0,000. The company has acquired a power-site on Lawyer's Canyon Creek, above the railroad bridge, and by moderate development will be able to generate 500 hp. Among list is a large machine shop that will be complete in every detail and will be equipped to handle all kinds of farm and milling machinery. Those interested are W. J. Ramoy, W. L. Lyons, J. Tyler and J. B. Davis all of Vollmer.

LOS ANGELES, CAL.—When the $40,000,000 Pacific Light and Power Company has completed its present plans for the rebuilding of the great Redondo Beach power plant, it will have one of the greatest plants of its kind west of Chicago. Ground will be broken this week, and the plant will be in operation by November 1st. More than $1,000,000 will be expended on the plant alone, while the distributing system throughout Southern California will be enlarged to the extent of $2,000,000. New engines will be installed and new turbines will go into present building, where pumps are in operation.

RICHMOND, CAL.—At the last meeting of the City Council Mr. Kline, of the Pacific Gas and Electric Company, said: "Our engineering department is busily engaged in getting out plans for a large distributing plant, to be constructed in your city at a cost of something like $75,000 or $100,000. We expect to proceed within 60 days with the work of installing this system and piping your city with mains for the distributing of gas. We propose to lay the mains so as not to interfere with the present improved streets. We are anxious for the co-operation of your citizens and in a short time will make a canvass of your town and endeavor to get a large patronage lined up. We propose to extend our distributing system to all parts of the town where the same will give us a reasonable return upon our investment. Your people will be highly pleased with our system and we are anxious for their co-operation." It is understood that the company will pipe the west side of town and supply all residence districts with the commodity.

LOS ANGELES, CAL.—The San Joaquin Light and Power Company, a subsidiary of Huntington's Pacific Light and Power Company of this city, announced Tuesday that it will at once begin the expenditure of $1,250,000 on a plant on the North Fork of the San Joaquin River, near Fresno, where a minor plant has been in operation several weeks. The larger plant will develop 22,000 hp. and supply light and energy to Fresno, Madera, Fowler, Hanford, Selma and as far south as Coalinga and the adjacent oil fields. The immediate work involves the construction of a dam 125 feet high, behind which will form a lake sixteen miles in circumference and an unfailing water supply to run the immense turbines. This is but a step on the part of the $40,000,000 Huntington corporation toward development in that section as a part of its comprehensive California power system. Five millions will be used in the San Joaquin region alone within the next three years.

TRANSPORTATION.

SAN FRANCISCO, CAL.—The Board of Works has denied the United Railroads' application for a permit to lay tracks, erect poles and string wires on Presidio avenue.

HILLYARD, WASH.—The Great Northern shops at Hillyard are to be enlarged this spring. Machine and car shops are to be doubled and the repair and store tracks increased.

VALLEJO, CAL.—Information received from Sacramento states that within the next ninety days ground will be broken for the extension of the Northern Electric from Sacramento to this city.

LOS ANGELES, CAL.—The City Council has voted to sustain the Board of Public Utilities in its protest against the city's offering for sale a franchise for a street-car line along San Pedro street from Aliso to Seventh.

HONOLULU, H. I.—The plans for the extension of several lines of the Honolulu Rapid Transit Company have been submitted to the Territorial Superintendent of Public Works, Marston Campbell. Tracks will be laid on Young street, between Alapai and Kapiolani streets.

SAN FRANCISCO, CAL.—The Supervisors have determined to defer consideration of the Bancroft bill to compel the United Railroads to run the Sutter-street cars down the inner rails of lower Market street until after the meeting of the Public Utilities Committee April 13th, the date set for the discussion of questions arising from the street railway situation in lower Market street.

SACRAMENTO, CAL.—Charging that the Santa Fe Railroad, instead of promptly delivering in Marysville fifty ballast cars turned over to the corporation in Detroit, Mich., for that purpose, filled the cars with merchandise and used them for its own purpose and for the benefit of its patrons, the Northern Electric Railway Company has begun suit for $20,544 damages. The cars were needed by the electric company in connection with the construction of its tracks between Chico, Marysville and Sacramento.

BELLINGHAM, WASH.—The final contract between the subscribers to the interurban fund and Stone & Webster, who agree to build an electric line between Bellingham and Sedro-Woolley, Burlington and Mt. Vernon, in Skagit County, has been drawn up in the office of Newman Howard and approved by the legal committee. The contract has been signed by Geo. Cooper, chairman of the committee and trustee for the Supervisors, and sent to the Stone & Webster representatives in Seattle for their signatures. It is now assured that work will be started immediately.

SAN FRANCISCO, CAL.—The San Francisco Suburban Improvement Company, a corporation with a $500,000 capital,

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has promised to build its proposed road if the residents of the Sunset District and others interested will subscribe the difference between the market and the par value of the bonds to be issued. The proposed route of the line would start in Parnassus avenue, at the end of the Masonic-avenue car line, to Third avenue, to J street, to Ninth avenue, to Pacheco street and Ninth avenue, a distance of one and one-half miles. The cost of the road is estimated at $80,000, and of this sum the San Francisco Suburban Improvement Company has subscribed $60,000. It is desired that the residents of the district subscribe the difference of $20,000.

EVERETT, WASH.—Eastern stockholders of The Washington Railway & Electric Company have taken over the interests of C. A. Hudson and J. C. Denny of Everett, Geo. D. Emery of Seattle and J. Kirkpatrick of Butte, and have begun work to harness the waters of the Sultan River at an estimated expenditure of $3,000,000. The plan is to build a concrete dam 120 feet high to conserve the waters, which engineers estimate will generate 50,000 hp. Further plan of the company is to construct a railroad from Sultan Canyon to the town of Sultan, 17 miles long. The power to be generated will be radiated to various cities on Puget Sound for industrial purposes.

FRESNO CAL.—The contract with the construction company in charge of the construction of the Fresno-Hanford Interurban Railroad has been rewritten to the complete satisfaction of the officials of the Hudson Counties Company of New York, according to an announcement by Sig Wormser, president of the local company, and it is believed by the directors that the rest of the bond subscription for the company will be shortly completed. The arrangements with the Hudson Counties Company provided for the subscription of $150,000 of the bonds by local capital, the Hudson Counties Company to then take over the remaining $850,000 of the stock. It is reported on good authority that $100,000 of the bonds have been taken in this section and that the rest of the subscription is assured. F. J. Haber, president of the Realty Association, who has this work in charge, declined to make any definite statement as to the amount taken up, but said that the outlook is promising. The canvassers are still at work. Mr. Wormser states that the newly written contract insures that the local board of directors will have complete power to protect all stockholders. He denied that all of the $150,000 worth have been subscribed.

WATERWORKS.

CATHLAMET, ORE.—The Council has decided to install a municipal water plant for Cathlamet. The estimated cost is $4,000.

HOOD RIVER, ORE.—Sealed proposals will be received by the Common Council up to 8 o'clock April 25th for the furnishing of material and labor for the construction of a complete municipal water system.

CLIFTON, ARIZ.—The Arizona Copper Company has applied to the Town Council for a franchise granting them the privilege of laying a new tailings pipe line through the residence section of Hills Addition.

SEATTLE, WASH.—The Council has passed an ordinance providing for the improvement of West Sixtieth street from Twenty-sixth avenue northwest to Thirty-second avenue northwest, by constructing water mains.

MOUNTAIN HOUSE, IDAHO.—The Council has passed an ordinance granting to the Commonwealth Power & Water Company a corporation of Spokane, Wash., a franchise for the furnishing of water for the city. The construction is to be commenced 60 days after the date of passing the ordinance.

RED BLUFF, CAL.—A notice has been filed appropriating 300,000 inches of water from the Sacramento River, about eight miles north of Red Bluff. As the location is near the Iron Canyon it is thought that the filing was in the interest of that project.

BERKELEY, CAL.—The City Council held a conference with Engineer H. Wilhelm and C. D. Maloney, representing the People's Water Company, recently, concerning the installation of an additional system of water mains in the city. The company proposes to expend $4 000 during the present year.

EAST LAS VEGAS, N. M.—The Agua Pura Water Company will make extensions in its system, and F. H. Pierce, manager, has engaged a consulting engineer from Boston, H. P. Eddy, and is prepared to inspect the water company's plant and make a recommendation. After inspection large mains will be installed.

SANTA ROSA, CAL.—An ordinance was passed by the Board of Supervisors, granting to L. Lewis, his heirs and assigns, the franchise, right, privilege and permission to lay, place, construct and maintain, under, through upon, over and across any or all of the county roads, highways, bridges, public ways, in the County of Sonoma, pipes, pipe lines and conduits with necessary service.

FRESNO, CAL.—A trust deed has been placed on record from the Coalinga Water and Electric Company of Fresno to the Southern Trust Company of Los Angeles to raise money to pay existing indebtedness acquire additional rights of way and secure plant and equipment, assigning $2,000,000 bonded indebtedness and mortgaging real and personal property in Fresno and Kings counties namely, machinery at the generating station, also the distributing system and the fractional block 10 of Coalinga, also franchises.

LONG BEACH, CAL.—The towns of Chinook and Long Beach are planning to unite in securing an adequate water supply for the two places. The source of the supply is Press Creek, about three miles from Chinook where, by constructing a dam across a canyon, a large reservoir can be formed at a sufficient elevation to provide a gravity system. To supply Long Beach will necessitate the construction of a main eight miles in length, and the railway company will be requested to grant permission for laying the pipe along its right of way.

SAN FRANCISCO, CAL.—R. G. Hanford, who, with William S. Tevis and a number of their following, has been engineering a plan to consolidate the People's and the Bay Cities water companies across the bay, has returned from another trip to New York, and is at the St. Francis Hotel. Mr. Hanford's return has caused a renewal of the talk of a water merger. Two previous attempts to reach the consolidation proved unsuccessful, and it was announced finally by Hanford and Tevis that they were through with the undertaking. It is said now that Tevis reconsidered his determination, having received assurances of certain concessions demanded by the promoters of the consolidation scheme.

OAKLAND CAL.—Mayor Mott believes that the cities served by the People's Water Company should band together and form a water district, under the provisions of the law established by the last State Legislature, and purchase the holdings of the corporation. Mott has proposed the matter to Mayor W. H. Noy of Alameda, who now has the project under serious consideration. The Mayor advocates the combining of the cities of Oakland, Berkeley, Alameda, San Leandro, San Pablo and Richmond, all of which are served by the People's Water Company, into one district for the purpose of purchasing the reservoirs, plants and system of the water corporation and placing it under municipal control.

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